NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE USE OF FORM, FIT, AND FUNCTION IN THE ACQUISITION OF MAJOR WEAPON SYSTEMS

by

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December 1985

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UNCLASSIFIED

ECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
. DECLASSIFICATION/DOWNGRADING SCHEDULE	
PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
. NAME OF PERFORMING ORGANIZATION aval Postgraduate School — 6b. OFFICE SYMBOL (If applicable) 54	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
. ADDRESS (City, State, and ZIP Code) onterey, California 93943-5100	7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5100
. NAME OF FUNDING/SPONSORING ORGANIZATION — 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

TITLE (Include Security Classification)
HE USE OF FORM, FIT, AND FUNCTION IN THE ACQUISITION OF MAJOR WEAPON YSTEMS

PERSONAL AUTHOR(S)
eets, Douglas M.

a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
aster's Thesis	FROM ______ TO ______	1985 December	102

. SUPPLEMENTARY NOTATION

COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Form, Fit and Function; Second Sourcing (dual sourcing); Competition

ABSTRACT (Continue on reverse if necessary and identify by block number)

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. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
a. NAME OF RESPONSIBLE INDIVIDUAL Prof. David V. Lamm	22b. TELEPHONE (Include Area Code) (408) 646-2775 — 22c. OFFICE SYMBOL Code 54Lt

D FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

#19 - ABSTRACT - (CONTINUED)

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The Use of Form, Fit, and Function in the Acquisition of Major Weapon Systems

by

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MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1985

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This research effort was undertaken to analyze the use of Form, Fit, and Function as a second sourcing methodology for major weapon systems. The major objectives of the research were to determine what the main attributes of Form, Fit, and Function were and how it could best be successfully employed.

The researcher found that Form, Fit, and Function would most likely not be used for the reprocurement of entire weapon systems. The real potential of this methodology was in the procurement of components and subsystems. In this regard, it can be used successfully for simple or technically complex items, initial or follow-on buys, and as a means of retrofitting existing equipments. Since there is no need to transfer technical data between sources as in the other second sourcing methodologies, Form, Fit, and Function can also be used when the transfer of technology is impossible, impractical or inappropriate.

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I. INTRODUCTION

A. GENERAL

Confronted with spiraling prices for both major weapon systems and spare parts, the Department of Defense (DOD) is turning more and more to competition as a means to get control of these escalating costs. However, there are other benefits of competition to be realized other than just cost alone.

DOD is not increasing its use of competition solely because it is "good business practice," but also becasue of the external pressures to aggressively seek competition for its acquisitions. This external pressure comes mainly from Congress through various avenues such as legislation and program support. It is in DOD's interest that competition for competition's sake not be solicited, but that competition be sought when it makes sense and helps to meet the objectives of the program. In seeking competition for a program, the program manager has several acquisition strategies that he may employ. The use of Form, Fit, and Function (F^3) is one possible strategy which can be used for creating competition.

The F^3 methodology is generally an approach which centers around the use of a performance specification. There is virtually no interface between competing sources and each contractor must be capable to design and produce its own product.

Therefore, competitors are essentially competing on the grounds of both design and price since each contractor is designing and producing an item independent of detailed drawings. This research effort will review the use of F^3 as a second sourcing technique in greater detail as it is used in the acquisition of major weapon systems.

B. OBJECTIVES OF THE RESEARCH

The basic objective of this study was to discuss the use of Form, Fit, and Function in establishing a second source for acquisition purposes.

C. RESEARCH QUESTIONS

In support of the objective of this study, the major research question was: What are the main attributes of the F^3 concept and how might this apporach best be successfully employed as a second sourcing methodology?

In answering this question, the following subsidiary questions were also considered:

1. What is the F^3 concept?
2. How does F^3 relate to other second sourcing methodologies?
3. What are the significant factors for its use?
4. What have been the significant issues or problems raised with the second sourcing of sonobuoys and the Standard Central Air Data Computer?

D. RESEARCH METHODOLOGY

In writing this thesis, the information discussed and analyzed was obtained from various sources. In addition to

searching currently available literature, both telephone and personal interviews were conducted with both military and civilian Government employees such as program managers and contracting officers. Other individuals knowledgeable in the acquisition arena were also interviewed.

The literature was compiled from references obtained through Defense Logistics Studies Information Exchange (DLSIE), DIALOG, Air Force Business Research Management Center, Lessons Learned Program from the Air Force, DOD directives and instructions, and the Naval Postgraduate School.

E. SCOPE OF THE STUDY

This thesis will be centered on employing F^3 as an acquisition strategy. In doing so, the other four methodologies will be briefly discussed so that the role of F^3 can be better analyzed. The thesis will include case studies of the acquisition of Low Cost Sonobuoys and the Standard Central Air Data Computer to see how and why program managers are currently employing this methodology.

F. LIMITATIONS

This Study was necessarily limited in that the acquisition of both the Low Cost Sonobuoys and the Standard Central Air Data Computer are in the early phases of their program life cycle. Therefore, an analysis of the effects of buying these equipments will be speculative of the benefits expected to be derived.

G. ASSUMPTIONS

Throughout this thesis, it was assumed that the reader has a basic understanding of the acquisition process and DOD terminology, operation, and management structure.

H. ORGANIZATION OF THE STUDY

This thesis is organized into six chapters. Chapter II describes the major weapon system acquisition process, the role of second sourcing, and competition. Chapter III is concerned with defining the Form, Fit, and Function concept, its attributes, and strengths and weaknesses of the methodology. Chapter IV provides a review of two second sourcing models available for the program manager, the Second Sourcing Method Selection Model and the F^3/D^3 Acquisition Decision Process Model, and how they relate to the Form, Fit, and Function technique. Case studies of two contrasting programs using this methodology for establishing second sources are the topic of Chapter V. Chapter VI provides conclusions and recommendations based on this research effort.

II. FRAMEWORK AND BACKGROUND

A. MAJOR SYSTEMS ACQUISITION PROCESS

The acquisition of a major weapon system is a monumental undertaking that requires considerable review and visibility to ensure that Government funds are being wisely spent. As larger and larger budgets are needed to procure these systems, the overview by both internal and external sources becomes much tighter. This necessitates that the Services do a better job on the business side in fielding new weapon systems.

The acquisition process begins with the recognition of a need to meet a new threat, perceived or real, or a new system to meet an existing threat (see Appendix A). This need is then communicated to the Secretary of Defense (SECDEF) via the Justification for Major Systems New Start (JMSNS). Based on this document, SECDEF either disapproves the initiative or decides that there is a viable need to meet the threat and gives his approval to go ahead with the program [Ref. 1: p. 3-12].

At this point, a program manager is assigned and given a Charter. The new program now officially moves into its first of four acquisition phases, the Concept Exploration phase. During the Concept Exploration phase, solicitations are made from as many sources as possible, Government and non-Government, and profit and non-profit organizations to

develop possible solutions as means to satisfying the need. Additionally, in-house studies must be conducted in order to establish some criteria by which to evaluate and test proposals. These criteria must cover such areas as required cost parameters, performance, schedule, and supportability, i.e., program baselines [Ref. 1:p. 3-13]. The program manager must also begin developing an acquisition strategy.

The objective of the Concept Exploration phase is to identify those alternatives which will meet the need so that they can be further developed and evaluated in the following phase. Along with looking at the functional and performance capabilities, proposals should include estimated life cycle cost (LCC) factors that will be used for evaluation and selection purposes [Ref. 2:p. 9].

The major documents coming out of this phase are the System Concept Paper (SCP) and the Test and Evaluation Master Plan (TEMP). Program Objective Memorandum (POM) input is also critical at this stage in order to attempt to get funding for the program. Upon review of the SCP, the Defense Systems Acquisition Review Council (DSARC) makes a recommendation to the SECDEF concerning further development. If the SECDEF, or other Program Decision Authority (PDA), approves the system, it moves into Phase II, Demonstration and Validation.

During the Demonstration and Validation phase, contractors who have shown plausible solutions to meeting the threat are awarded contracts to prepare mock-ups and models or selected

systems. The contractors demonstrate how well they can meet the criteria set forth in Milestone I. As stated above, these criteria consist of such objectives and thresholds as cost, schedule, performance, and supportability requirements [Ref. 1:p. 3-13]. These baseline characteristics are continually modified and updated throughout the life of the system. If the SECDEF or PDA is assured that these requirements have been or can be met, he prepares a Secretary of Defense Decision Memorandum (SDDM) which indicates that the program is ready for the third phase, Full-Scale Development. The Full-Scale Development phase signifies that the final product is being narrowed down and that only a few contractors are still in the competitive range. The competitive range consists of those contractors whose proposals are acceptable. These few contractors then produce full scale versions of their proposed systems to be tested and evaluated. This is an extremely critical phase since the final decision to produce will be based on prototypes and pilot production units resulting from this phase. Also during this phase, more accurate LCCs will be estimated, baseline configuration will be set, technical data packages will be prepared, and the overall suitability and producibility of the system will be critically reviewed [Ref. 1:p. 3-16].

Upon completion of reviewing and evaluating the alternatives, the Services (or DSARC in certain cases) will make the recommendation to go into production and the new system now enters the final phase, Production and Deployment.

It is in this phase that generally one contractor is awarded a production contract and the program manager finds his program in a sole source situation. Unless the program manager takes decisive steps to avoid finding himself in this position, the program could possibly be a sole source contract for the remaining life of the contract [Ref. 3: p. 15]. Second sourcing is a means to preclude this situation from happening. The earlier in the acquisition process the program manager considers second sourcing, the more effective it will be when production is competed.

B. COMPETITION IN CONTRACTING

1. Definition of Competition

Webster's definition of competition is "the effort of two or more parties to secure the custom of a third party by the offer of the most favorable terms" [Ref. 4:p. 464]. Competition in the context of acquisition, as defined by a proposed Naval Air Systems Command (NAVAIR) instruction, is the "solicitation of two or more sources for the delivery of a suitable and acceptable product during the development, production, and post production (support) phases of the acquisition cycle" [Ref. 5:Encl (1)]. According to the Federal Acquisition Regulations, full and open competition means that "all responsible sources are permitted to compete" [Ref. 6:para 6.003].

These are very broad guidelines for the program manager to work by, but in fact, competition is becoming a much

broader concept. Increasingly, competition is becoming a multi-dimensional national objective used by Congress and the Services to consider price, quality, the industrial base, and socio-economic programs in the acquisition of major items [Ref. 7:pp. 2-9].

2. Competition in Legislation and Regulation

The use of competitive procurement has been a main tool of Congress since the inception of the United States to help realize lower prices and forestall procurement abuses. The first legislation specifically dealing with procurement was the Procurement Act of 1809 [Ref. 7:pp. 2-3]. As a result, formal advertising was to be used to enhance competition for goods and services utilized by the Federal Government. However, due to the increasing complexity of systems and the ever increasing volume of purchases, negotiated contracts began to be used before the start of World War II [Ref. 7: pp. 2-3].

Somewhat in response to this change in technique, Congress passed the Armed Forces Procurement Act of 1947 which legitimatized the use of negotiation when any of seventeen "exceptions to competition" were applied [Ref. 7:pp. 2-3]. This law in no way attempted to replace or downplay the importance of competition, but took into account the fact that the use of competition is not desirable nor possible in all situations.

As major weapon systems began to get more and more costly, Government again became concerned with the acquisition process and issued two more guidelines regulating competition. One was the Office of Management and Budget Circular A-109, "Major System Acquisitions," in 1976 and Congress' Department of Defense Appropriations Act of 1984.

In 1981, Deputy Secretary of Defense Frank C. Carlucci submitted a memorandum to the various Service secretaries entitled "Improving the Acquisition Process" [Ref. 7:pp. 2-4]. He identified 32 areas or initiatives to improve the major system acquisition process. The last of those initiatives was to "Increase Competition in Acquisition by Establishing Management Programs and Setting Objectives."

Revisions to DOD Directive 5000.1, "Major Systems Acquisition," and DOD Instruction 5000.2, "Major System Acquisition Procedures," were made to reflect the initiatives of Carlucci's Memorandum and also OMB Circular A-109. These two documents are key guidelines and directives used today.

In February 1984, the Office of Federal Procurement Policy (OFPP) issued Policy Letter 84-2 entitled "Noncompetitives Procurement Procedures" [Ref. 8:p. 1-3]. The focus of this policy is to strictly limit the use of sole source procurement and authorize its use only when one of seven exemptions is used. Most recently, the Federal Acquisition Regulations and its service and departmental supplements have been issued in an attempt to standardize the procurement practices in

Government and to encompass the many new laws and regulations regarding competition [Ref. 8:p. 1-4].

3. Design Competition vs. Production Competition

Design competition and production competition are two distinct, independent concepts. Design competition is the process of "generating alternative potential solutions to satisfy a mission need, and the selection of the best system, price, and other factors considered" [Ref. 9:pp. 17-18]. Production competition is a method of "obtaining competitive offers from two or more independent, qualified manufacturers for the production of identical, or functionally identical, hardware or software" [Ref. 9:p. 18]. They are stressed at different times during the acquisition process, handled differently by Government and contractors, and have totally different objectives and incentives. One should not be considered better than another nor should one be considered sufficient if used without the other.

Design competition is heavily concentrated in the early phases of the major system acquisition process. The program manager desires to stimulate as much competition as possible during the Concept and Exploration phase to take advantage of industry, Government, and non-profit institution talents and resources in developing solutions to meet the threat and to further develop promising solutions in the Demonstration and Validation phase.

The contractor goes into this form of competition with the hope of winning an award to produce a weapon system. His other incentive is that the contracting officer is generally using a cost reimbursement contractual arrangement since there are so many uncertainties and questions that flexibility to changes is a must.

The major thrust of the contractor is still to receive the production contract. In doing so, the contractor must ensure that he is providing a proposal that is producible, supportable, and affordable. According to former Deputy Secretary of Defense Charles W. Duncan, Jr., the goal of design competition "is to award the contract to the best technical proposal within a realistic affordable price" [Ref. 9:p. 18].

Production competition occurs later in the acquisition process during the Full-Scale Development and Production and Deployment phases. It entails soliciting and obtaining proposals from two or more competitive sources who are qualified to produce identical or similar systems. Unlike design competition which is concerned with "realistic" prices, production competition is concerned with obtaining the lowest "fair and reasonable" price for the system" [Ref. 9:p. 18]. The contractor's main incentive is now to make a profit by producing the weapon system. The contracting officer usually uses a fixed price-type contract to help stabilize the purchase price since the program is often in a sole source position.

Price is not the only goal of production competition. Two other goals are to enhance the defense industrial base and to stimulate improvements in quality [Ref. 8:p. 1-11]. At times these goals may conflict but it is up to the program manager to ensure that he is influencing competition to meet the needs of his program [Ref. 1:p. 4-7].

4. Perfect Competition vs. Effective Competition

In addition to design and production competition, competition can be defined as either perfect or effective. Perfect competition is a condition whereby one buyer (or seller) cannot effect the market price of the product to be sold [Ref. 10:p. 298]. To have perfect competition, the market must have effective competition. The reverse however, is not true. Perfect competition is very rare and is almost non-existent in the defense market. To have a perfect market, there must be four characteristics present [Ref. 10:p. 191].

a. There must be many buyers and sellers so that no one buyer or seller has an influence on the market.

b. All of the sellers' products must be homogeneous.

c. Buyers and sellers are free to move into and out of the market as they please.

d. Buyers and sellers have perfect knowledge of current market prices and sellers have perfect knowledge of costs.

The make-up of the defense market is such that none of these characteristics can be fully met. However, the program manager can exert enough influence on the market in many cases so as to realize at least effective competition

for his program. The definition of effective competition is that as a result of competition, the expected value of the benefits realized exceed the expected value of the costs. The value of the benefits and costs can be measured in both monetary and nonmonetary terms [Ref. 9:p. 21]. Examples of non-monetary benefits could be increased industrial base and technical expertise.

The program manager must be careful when trying to establish an effective market. Too many sellers could possibly cause costs to exceed benefits if his program is funding research or production capacity.

C. SECOND SOURCING

1. Definition of Second Sourcing

Many literature sources consider second sourcing and competition syonymously. There are, however, significant differences that should be brought out to avoid confusion and maintain a distinction between the two terms. Second sources are established to either maintain competition or increase competition between two or more sellers or increase competition or to maintain an industrial base capable of supporting the buyer's needs. The distinction is that competition requires a second source whereas establishing a second source is not necessarily used to instill competition [Ref. 11: p. 1-2].

2. Objectives of Second Sourcing

There are two basic second sourcing goals [Ref. 3: pp. 18,19]:

a. the control and/or reduction of cost, and

b. the maintenance of an adequate industrial base.

However, there are several other objectives which can be realized through second sourcing. They are:

a. lower acquisition price by using competition,

b. improve mobilization capability,

c. promote geographical dispersion so as to preclude destruction of an only source due to natural disaster or enemy attack and qualify new sources who possess specialized technologies,

d. smooth out fluctuations in production for individual firms caused by sole source awards,

e. needed Government controls are lessened due to the presence of competition,

f. increase technical performance by increasing technical or design competition,

g. more fully meet socio-economic goals by increasing awards to minority and small/disadvantaged businesses, and

h. increase ability to meet commitments of co-production agreements for NATO programs.

3. The Roots of Second Sourcing

The concept of second sourcing goes back to just after World War I. The Government funded the Chandler-Groves Company to develop a floatless carburetor for aircraft engines. Several attempts to get Stromberg-Carlson to design an acceptable carburetor were unsuccessful since, for all intents and

purposes, Stromberg-Carlson had a monopoly on the market. As a result of this bold step by the Government, Stromberg-Carlson went to work and developed a pressurized carburetor which would eventually be used in all United States military aircraft in World War II [Ref. 12:p. 4].

During the Korean War, the Government felt that Boeing's facilities were too limited to produce enough B-47 bombers to satisfy the military's requirements. Therefore, both Douglas Aircraft Company and Lockheed Aircraft Corporation were geared up to produce them. Boeing provided all tooling, technical data, components and parts [Ref. 12:p. 4].

Not until the late 1960's was the concept of second sourcing defined in the literature and regarded as a bonafide means of increasing competition. Second sourcing has basically evolved in four phases [Ref. 12:pp. 4-6]:

a. 1920's--second sourcing was employed to stimulate technological advances.

b. 1950's--second sourcing was implemented to increase production capacity where shortfalls were anticipated. The second sourcing tactic of Leader-Follower had been used before the term had even been coined. Mobilization at the time of war was the driving force in establishing additional sources of supply.

c. 1960's--the establishment of second sourcing to intensify competition was first defined. Second sourcing was then seen as a viable tool for establishing competition to help control costs.

d. 1970's to present--greatly increased cost cutting efforts have expanded second sourcing's role in procurement strategy. Much research is being conducted in this field. Second sourcing is now seen as a means to reduce risk in the acquisition of major weapon systems. Risk in this sense entails the three elements--cost, schedule, and technical risk.

4. Barriers to Establishing a Second Source

If a program manager decides that second sourcing would be beneficial for his program, he must investigate any barriers which may preclude second sourcing. In looking at possible barriers, there are four general areas which should be considered [Ref. 13:pp. 20-26].

The first is the process by which technology will be transferred. This area frequently poses problems in establishing second sources. Some questions which arise are how much it would cost if two firms had to work closely together and the reliability and completeness of the available technical data package. If the manufacturing process is hard to duplicate it may be very difficult and expensive to ensure effective data transfer which is sufficient to support a second source.

Secondly, the program manager must consider the characteristics of the system. If a system is state-of-the-art, other sources may be inhibited from investing in the capital assets needed to perform the job. Also, the possibility of requiring a long lead time to bring on line a second source may not make it conducive to bringing on a new source. The necessary security requirements for the system may also have an influence.

Third, the characteristics of the acquisition process may play a role in the decision to second source. Larger quantities tend to be better candidates than small quantities,

especially if the original producer cannot keep up with demand. Program stability and duration should also be heavily weighed.

Lastly, one of the most important considerations is that of the characteristics of the contractors involved. A contractor who wants to maintain his hold on a program may be hard to motivate to help bring a competing source on line. It must also be determined what other sources have the capability to perform.

5. Second Sourcing Methodologies

Once a program manager decides to stimulate competition by developing a second source, he must decide how it should be accomplished. There are five strategies currently identified which are being used and researched in order to establish a second source. These methods are form, fit, and function; technical data packages; leader-follower; directed licensing; and contractor teaming [Ref. 14:p. 13].

a. Form, Fit, and Function (F^3)

F^3 is a second sourcing strategy that relies on performance specifications and physical specifications such as size, weight, mountings, and interfaces. Since there is no need for communication between the sources, internal hardware design flexibilities are expected and solicited. As a result, a very hard look must be taken at a firm's research and development assets as well as its production capabilities during the source selection process.

F^3 lends itself to both inexpensive, simple components and very expensive, complex items. It has been

successfully used in procurement for items ranging from conventional ammunition to aircraft engines [Ref. 8:p. 9-11]. This particular methodology will be dealt with at length in the following chapter.

b. Technical Data Packages (TDP)

TDP is a method of creating a second source by means of transferring technology and design characteristics without any interface between the developing firm and the second source. This acquisition strategy has been used for procurements ranging from the simplest of components to complete missiles. The main concern of the program manager when using this method is to ensure that the new source has adequate production capability and facilities to handle the job. All research and development efforts have already been completed unlike the F^3 method.

The major criteria for the TDP procurement is that the data must be complete with all drawings, parts lists, specifications, and in some cases, detailed description of the manufacturing process. In some circumstances, the developer is being requested to warrant the TDP that it sells to the Government to ensure that it is complete and accurate. Periodically, legal questions are raised concerning proprietary data. Because of these problems, TDP is often very expensive and hard to get.

Once the data is assembled and verified, however, it can be used over and over again throughout the life of the

system or component. The advantages of using this strategy are [Ref. 15:p. 14]:

(1) Verified TDP should promote good competition and result in a fairly easy procurement action.

(2) The design work is done at this point and companies are now bidding on a production basis only, which should open it up to more bidders.

Some disadvantages are [Ref. 13:p. 14]:

(1) TDP that is adequate to attract competition is very expensive and occasionally hard to obtain which may somewhat off-set any savings.

(2) When technical processes or methods are not spelled out or readily accessible to other firms, the bidding firms must have the technical capability to resolve the problem.

(3) The program manager must start early in the development stage getting the data packages assembled and verified.

c. Leader-Follower

Leader-follower is very different from the previously discussed methods in that there is direct communication between the firms. The developer is tasked with furnishing the technical know-how and assistance required to bring the second source on line. This method is generally used for large, complex components or systems. Leader-follower is usually applied when the desired result is increased production capacity [Ref. 14:p. 16].

FAR states that the leader-follower technique can be implemented by one of three ways [Ref. 6:para 17.403]. One is to state in the developer's contract that it is to subcontract a designated portion of the resuirements to a second

source. A second way is to award a contract to the developer to bring a new source on line then contract with that new source for some of the requirements. The third alternative is to award a contract to a second source for the end item, who will in turn contract with the developer to transfer the technical data and knowledge required to manufacture the item. The third method is questionable because the developer is under no pressure to deal with the other source and has never been used on military acquisitions because of this potential problem [Ref. 8:p. 11-12].

The advantages of this method are [Ref. 15:p. 16]:

(1) Second sources can be established quickly and efficiently.

(2) The Government has very little hands-on requirements and responsibilities.

(3) Leader-follower has proven extremely successful when it has been used.

The major drawback is that some companies do not put their best effort into helping establish a competing firm because under the leader-follower concept, they will not receive any royalties.

d. Directed Licensing

Directed-licensing is similar to leader-follower in that the developer provides technical and manufacturing data to a second source. The notable differences are that the developer will receive royalties and he does not forfeit proprietary data rights. The engine for the cruise missile

is a recent case where directed licensing has been used effectively [Ref. 16:p. 68].

Some advantages of this method are [Ref. 15:p. 15]:

(1) The developer is obligated to assist the second source in setting up its production line through contractual agreements delineated in the Full-Scale Development contract.

(2) Since the developer is receiving royalties, it is more likely that the developer will be cooperative in getting the second source on line.

(3) The developer is allowed to select a possible second source, with concurrence from the Government, which removes a significant amount of work from the Government.

(4) The Government can pass on much of the work of starting up a new source with little effort and without the expense of having to buy a TDP.

The disadvantages are [Ref. 15:p. 15]:

(1) The effect of competition could be negated if the royalty fee offsets the savings.

(2) Some unscrupulous contractors may use it as a means of getting access to another firm's trade secrets.

(3) It may be difficult to maintain configuration control unless the firms' production lines are closely monitored.

e. Contractor Teaming

Contractor teaming is a method that has found recent success in complex systems where two contractors, working in unison, each develop a part of the item and then transfer the technology between themselves. Both firms must be able to manufacture the complete item and then they are qualified in that process concurrently. Once both teams have qualified, they bid competitively for the production contract.

A key point of contractor teaming is that after a team has been chosen and both qualify for production, there is only one contract awarded. In making the award, there are two routes that could be taken. One is that a prime contractor could be chosen and in turn subcontract with the other firm to produce a percentage of the items. A second alternative is that the two firms could form a joint venture to whom the Government could award the contract. This is a split-buy technique and is often used in the shipbuilding industry.

Some advantages to contractor teaming are [Ref. 14: p. 16]:

(1) Since two contractors are qualified, a second source already exists when the contract is awarded.

(2) Since there are two firms working together to develop the item, there should be a greater research effort put forth thus minimizing proprietary data problems.

(3) There are no royalty fees holding the price artificially high.

(4) While honest competition is not really increased, the industrial base is.

Disadvantages of contractor teaming are [Ref. 14: p. 16]:

(1) Research and development costs may be initially high since the Government must pay the burden of two firms.

(2) There must be open lines of communication between the firms, and if a joint venture exists, the relationship must remain solid.

D. SUMMARY

The purpose of this chapter was to present a framework of the competitive atmosphere in which today's program manager

and contracting officer must function. It is also intended to present the various second sourcing techniques to give the reader a better perspective of how Form, Fit, and Function relates to the other methodologies when reading the next chapter.

III. FORM, FIT, AND FUNCTION

A. DEFINITION

Form, Fit, and Function (F^3) is a second sourcing technique used to develop competitive sources based on the performance specifications and external interface requirements of a system. The F^3 method allows and encourages competing sources to develop internally different systems as long as the system satisfies the form, fit, and function parameters set forth in the solicitation. These parameters may include such characteristics as size, weight, external dimensions, power requirements, and mounting provisions in addition to the performance requirements. Thus, F^3 is sometimes considered the classical "black box" concept [Ref. 14:p. 13].

Since F^3 acquisitions are based on functional specifications, the different manufacturers' systems are ones that are functionally interchangeable but not logistically interchangeable. As a result, F^3 has often been associated with such simple, non-technically oriented components as the GAU-8 30-millimeter ammunition and the technically complex, but still maintenance-free, sonobuoys [Ref. 8:p. 2-4 and Ref. 17]. However, F^3 has also been used to acquire such components as the Alternate Fighter Engine and Standard Central Air Data Computer [Ref. 8:p. 9-1 and Ref. 18]. F^3 has also been used to purchase components which are repairable at the field level,

but have demonstrated such high reliability that repair is seldom necessary.

B. ELEMENTS AND ATTRIBUTES OF FORM, FIT, AND FUNCTION

1. General

When properly planned and executed, F^3 has proven to be an extremely effective means of second sourcing as evidenced by such successful programs as the GAU-8 30-millimeter ammunition and sonobuoy programs. However, because of logistic support problems inherent in an F^3 acquisition, this methodology will probably not be used to second source the reprocurement of a complete weapon system [Ref. 19]. Its major role is in the acquisition of the components within the system. Many of those interviewed considered F^3 to be used as a means of retrofitting a current system, while others believed it could be successfully used at the front end of a major system buy.

Regardless of when it is used, F^3 allows a maximum of flexibility for the user in selecting from proposed technologies [Ref. 20:p. 23.5.1]. F^3 also puts the risk of ensuring that the equipment will perform as required in the hands of industry by letting them drive the technology [Ref. 21].

F^3 is often chosen over the other second sourcing methodologies when technology is advancing so fast that it would be impracticable to try to buy and maintain a TDP or if the manufacturing process is so complex it becomes an

"art" which would make it nearly impossible to transfer the technology [Ref. 22]. F^3 can also be effective if the program manager has a bad design that he wants to correct [Ref. 23]. In this respect, F^3 can be used roughly as a form of value engineering. This point is brought out in the Air Force's lessons learned data bank involving a parametric amplifier which was experiencing poor reliability [Ref. 24: Call Number 0521]. Taking advantage of a new state-of-the-art signal mixer, a form, fit, and function replacement of the ailing amplifier resulted in increased performance and lower maintenance costs.

The program manager may find that this methodology helps his program in other respects. If the program manager wants to obtain a warranty for the equipment, he may get a much more favorable response from the contractor if the contractor is allowed to use his own design rather than build to a predetermined design over which he has no control [Ref. 25]. Also, the program manager may find that his engineers are so wrapped up in administrative details that they often become ineffectual in maintaining and managing a TDP which requires much effort on their part [Ref. 22].

2. <u>Dependency On The Original Supplier</u>

Since there is no transfer of technology using this second sourcing methodology, there is no dependency on a current supplier to cooperate in developing a new source. This attribute has occasionally resulted in this technique being

employed when an uncooperative contractor refuses to assist in establishing a second source. Competition for the cruise missile engine was achieved by using F^3 as a means to bypass the original supplier [Ref. 8:p. 9-4].

One major attribute of F^3 is that there is no need to purchase a TDP to be used for later reprocurement unless the program manager has decided to use F^3 for only the initial buy and not for reprocurement purposes. TDP is very expensive to buy and is often unusable for reprocurement purposes until it is validated. This validation process can be long and costly. Also, TDP must often be scrubbed of proprietary data before other contractors can use it. TDP may also contain unique production processes which precludes intercompany transfer of technology [Ref. 24:p. 4]. This protection of data is one reason why contractors often prefer to manufacture to a performance specification since they do not have to relinquish any proprietary data. In addition they can utilize their own parts and suppliers.

3. Relation To Competition

Many sources consider F^3 as a more truly competitive means of acquiring equipment over the other methods. The reason for this is that there is competition over design as well as price. The other methods rely either directly or indirectly on the transference of detailed data which strictly dictates a given design so that competition is based primarily on price. The drawback is that by using an F^3 approach, the

program manager may be limiting the number of perspective competitors since design and technical capabilities in addition to production capabilities are a must.

This concept is also in keeping with the Office of Management and Budget Circular A-109, Major Systems Acquisitions, which stipulates that equipment needs should be stated in terms of mission needs, capability, cost objectives, and operating constraints [Ref. 27]. This allows the contractor to inject his own ideas and technology into the system. The contractor is not tied down to a single production process which he may or may not be able to duplicate.

This use of industry's technical capabilities helps to maintain not only the industrial base for production capabilities, but may also help to finance the technical expertise needed to keep pushing the state-of-the-art by funding several research and development (R&D) efforts. However, in helping to maintain this capability by using F^3 to instill competition, the program manager must be willing to incur some extra costs. These costs of competition include the cost of requalification of contractors, increased R&D expenses, logistics support requirements, and possibly increased administrative costs.

The program manager should also be sensitive to the fact that the use of F^3 can be counterproductive to competition if not properly controlled. For example, if there were changes that needed to be made to the system, one contractor could become non-competitive if he had to make drastic changes to

his product whereas another contractor did not have to make such changes because they used different technologies [Ref. 27]. Also, the F^3 package should not restrict competition due to arbitrarily derived specifications which favor one contractor over another [Ref. 20:p. 23.5.2].

4. Logistic Support

Logistic support problems are considered by many to be the biggest single drawback to using F^3 [Ref. 17]. For this reason, most applications are for those equipments which are expendable and not going to be repaired. More and more buys, however, are being made for equipments which are going to be maintained, but not at the shipboard level. In these cases, the equipment could be removed and replaced at the shipboard level but repaired at the depot level. This repair may be done by the contractor [Ref. 17].

Logistic support problems center around the fact that there is no configuration control over the internal make-up of the equipment [Ref. 11:p. 5-2]. If the equipment is to be repaired, repair data, personnel training, and spare parts for multiple equipments would have to be acquired. It is possible that there could even be several variations from the same source. Therefore, the level of maintenance must be set early in the acquisition cycle before the second sourcing technique is determined [Ref. 11:p. 4-1].

In order to realize the benefits of F^3 for repairable type items, program managers are turning to the manufacturer

for repair [Ref. 17]. This is being accomplished through either fixed type contracts or warranties. The program manager must be careful in this endeavor not to end up in a sole source situation because of the method used to repair the equipment.

5. Form, Fit, and Function Specifications

One of the major attractions of the F^3 concept is that performance specifications on a whole are much easier to write than design specifications [Ref. 21]. In addition, industry often helps to develop these specifications through standards [Ref. 28]. This is a widely used technique in the aviation industry and is currently being used in conjunction with the military to develop standardized avionic packaging concepts [Ref. 20:p. 23.5.4].

According to MIL-STD-885B, there are two basic kinds of procurement data packages referred to as form, fit, and function packages. One is for the competitive procurement of interchangeable items. It must include sufficient data to "enable the procurement of the same item from the original manufacturer, or the competitive procurement of a functionally and physically interchangeable item from other sources" [Ref. 29:p. 5].

The second procurement data package refers to an item existing in the market on an unrestricted basis. These are either off-the-shelf items or ones that are procurable from a specialized segment of industry. Suggested sources for

these items are normally identified in the package. [Ref. 29:p. 5]

There are some pitfalls with the use of performance specifications if due care is not taken. One problem is that engineers may not know what parameters are important or how some components may affect others [Ref. 19]. Examples of this are the C-130 Power Brake Control Valve and the MC-2A Air Compressor [Ref. 24:Call Number 0495]. These particular items have been plagued by performance problems due to poorly written performance specifications which did not control significant characteristics of the items.

This is particularly true if the system is untried and still in the development stage. During the development of the A-10 aircraft, the decision was made to forego a full-scale mockup since design was considered stable. This resulted in expensive modifications having to be made because form, fit, and some mechanical function parameters could not be verified without the mockup [Ref. 24:Call Number 0497].

If the system is extremely complex, there may be too many interfaces to describe them accurately enough to produce a clear specification [Ref. 30]. Because mechanical applications have interfaces which are hard to describe in a performance specification, most F^3 acquisitions are for equipments in the electronic field where there are more industry standards employed.

With the use of performance specifications, the program manager tends to lose control of the configuration of

his system [Ref. 23]. It is difficult to monitor and control the contractor in these situations, but Government engineers need to be completely aware of all the contractor's actions to ensure that the parameters of the overall system remain intact [Ref. 23].

C. SUMMARY

This chapter analyzed the second sourcing technique of Form, Fit, and Function. The viewpoints of several Government employees active in the major weapon system acquisition process and various literature sources were compiled to determine what the F^3 concept is and how it can best be used. The following chapter will discuss two second sourcing models and how they apply the F^3 methodology.

IV. CURRENT SECOND SOURCING MODELS

A. PREFACE

In conducting research for this thesis, two second sourcing models were identified that are available for the program manager to use. The intent of this chapter is to discuss these two models, address how they relate to F^3, and compare their strengths and weaknesses. These models are the Second Sourcing Method Selection Model (SSMSM) developed by two students at the Naval Postgraduate School and the F^3/D^3 Acquisition Decision Process developed by the Naval Avionics Center (NAC) for the Naval Air Systems Command (NAVAIR). These models are presented in Appendices B and C respectively.

B. SECOND SOURCING METHOD SELECTION MODEL

1. The Model

The objective of the SSMSM is to "provide a logical and systematic framework for evaluating the applicability of each of the competitive methods in light of variables presented in the acquisition situation" [Ref. 14:p. 18]. The outcome is to select the second sourcing method which best fits the needs of the program or at least to distinguish those techniques which should be eliminated from further consideration.

The SSMSM is broken down into two distinct acquisition situations, pre-production and post-production. Each of these models are significant because the variables should be viewed

differently depending upon when in the acquisition cycle the decision to second source is made.

The SSMSM is based on a heuristic overview of fourteen different variables. Being heuristic, the model does not attempt to assign numerical values to the variables, but simply rates the effectiveness of each of the variables according to the circumstances. The Air Force is currently attempting to adapt this model to use quantitative factors vice heuristic values [Ref. 28].

2. The Variables

The fourteen variables and how they relate to the model are described in Appendix B. How these variables relate to F^3 in particular, are addressed in this section [Ref. 14: pp. 16-21].

a. Quantity to be Procured

The total quantity and rate of purchase can greatly affect whether or not it is cost effective to second source an item. If quantities are too low or buys stretched out, the development of a second source may be costly. However, the Government may well pay the differential if the goal is increased mobilization.

While no second sourcing method is particularly attractice when low volumes are being sought, F^3 may be preferred over the other techniques. This is because F^3 is relatively simple to use and the fact that there is no expensive TDP to purchase and validate.

b. Duration of the Production

As quantity impacts on the second sourcing decision, so to does the production duration. The shorter the production time, the less likely second sourcing serves as a viable means to instill competition into the program. F^3 is generally less effected than the other methods because there is no dependency of one contractor on another. Each competitor is constrained only by his own technical abilities.

c. Learning Curve

The steeper the learning curve, the less effective second sourcing will be. This is due to the fact that the original producer will be able to realize an unfair advantage since he will be farther down the curve. It is the researcher's observation that during the pre-production phase, unless one of the competitors is the prime contractor, F^3 may negate any advantage of one competitor over another since they are not competing with the same TDP. Since they are using their own design and production processes, it is likely that they are not even using similar learning curves [Ref. 27]. Learning curves would have a larger impact on the post-production buys since one or more contractors is already in a production mode.

d. Technical Complexity

According to the SSMSM, the more complex the system, the more there needs to be an interface between the competitors. Hence, F^3 is best used when the complexity is lower.

Unless parallel development has occurred, F^3 may be very hard to implement [Ref. 31:p. 12].

e. State-of-the-Art

Increased contractor interface is essential as the program moves toward the leading edge of technology. As with technical complexity, F^3 becomes a viable alternative as the technology increases due to the uncertainty of the interfaces. Also, as the technology increases, fewer and fewer contractors have the capability to design and develop the components.

f. Other Applications

Second sourcing would be greatly beneficial to a program if the system has other applications, both governmental and commercial. F^3 is exceptionally good to use in these cases. Commercial products may be used which helps to control costs and standardization. Also, if an item has commercial applications, the contractor may not want to divulge trade secrets. Because F^3 relies on a performance specification, the contractor may not want to have to provide TDP since there is no transfer of data.

g. Privately Funded Research and Development

The amount of privately funded R&D could be a factor in determining whether to use F^3. If the R&D requirements were too high, regardless of whether funded privately or by the Government, competition may become severely restrained. On the other hand, one of the benefits of F^3 is the discovery of new technologies. As long as this R&D effort is funded

privately rather than through the Government, R&D should be encouraged. This is particularly true if the equipment would have other applications.

h. Unique Tooling

As the need for unique tooling increases, the chances of second sourcing paying off diminishes for all techniques. F^3 may be effected the least since the contractors might be able to develop new production techniques or methods which would preclude the need for special tooling they do not now have.

i. Cost of Transferring Unique Government-Owned Tooling

The cost of transferring Government-owned tooling weighs evenly among the second sourcing methodologies regardless of the cost level and thus has a negligible effect on which methodology is chosen. However, F^3 may have a slight advantage if the contractor proposes a system designed around his current capabilities.

j. Production Capacity of the Original Developer

When the original contractor lacks the capability to manufacture the needed quantities because of constrained capacity, it may become mandatory to establish a second source. If the original producer has excess capacity, it may be more costly to second source since overhead would be allocated to fewer goods.

k. Maintenance Concepts/Requirements

The maintenance concept which will be used is an essential element in the determination of the methodology to be used. If the system requires field level maintenance, the use of F^3 could severely limit the supportability of the system since there may or may not be any commonality between the components. The only exception to this is if the component has demonstrated such a high level of reliability that little or no maintenance is required [Ref. 31:p. 12].

l. Production Lead Time

The longer the time it takes to bring on a second source, the less positive effect second sourcing has on the acquisition process. This holds true for all methodologies. F^3 is especially sensitive to this for post-production buys since each contractor has to engineer, produce, and qualify his product.

m. Degree of Subcontracting

As the amount of required subcontracting increases, there is less benefit derived from second sourcing. This is particularly true if only a few subcontractors have the capability to do the job forcing the prime contractors to compete for their services. F^3 would be less susceptible to this potential problem since the prime contractors may be using different components to build their systems because they are using a different technology base.

n. Contractual Complexity

The more complex the contractual arrangements become between the Government and the contractor, the more difficult it becomes to create a second source. As requirements for life cycle cost parameters, warranties, and other arrangements are made, the problems compound as additional sources are added. F^3 would have less problems regarding contractual complexities than the other methods simply because there is no need for interaction between the competing sources which in itself increases the administrative workload.

C. F^3/D^3 ACQUISITION DECISION PROCESS

1. The Model

The F^3/D^3 Acquisition Decision Process developed by NAC is a four stage deterministic model used to decide which approach should be exercised to develop a sécond source: the F^3 approach or the detailed design disclosure (D^3) approach. The four stages are [Ref. 31:p. 3-1]:

a. Stage 1 is a review of the characteristics and situations surrounding the program to determine whether or not the program is ready for competition.

b. Stage 2 presents a decision model to determine whether an F^3 or D^3 acquisition approach should be used.

c. Stage 3 presents two additional models to use to decide upon a particular strategy once an approach has been selected.

d. Stage 4 offers a set of application guidelines that should be considered in applying an approach.

2. Definitions

Definitions are offered to clarify the model.

a. F^3 Acquisition Approach [Ref. 11:p. 5-1]

The F^3 approach is based on the use of the Government's functional specification that describes the equipment to the Weapon Replaceable Assembly (WRA) level. In addition to system partitioning, the specification describes the equipment's size, weight, external configuration interfaces, mounting provisions, type of power and performance characteristics. Equipments designed and manufactured by different contractors will meet the functional specification and will be interchangeable at the WRA level, however, each contractor will exercise a freedom of internal design. Consequently, each contractor's equipment will be functionally but not logistically interchangeable. There is minimal, if any, technology transfer between the contractors.

b. D^3 Acquisition Approach [Ref. 11:p. 5-1]

In the D^3 approach the FSD contractor has designed an equipment to meet the Government's performance specification and produces a technical data package which documents his design in accordance with certain Military Standards and Specifications. This approach permits production contractors, other than the developer, to manufacture identical equipments. Equipment manufactured by competitive production sources will be interchangeable at the WRA, SRA, and piece parts level (that is, functionally and logistically interchangeable). The required technology transfer may take on a wide range of options as to how the design data, manufacturing processes, and documentation are provided to competing production contractors. The most sophisticated technology transfer would be via a set of "stand alone" instructions, which represents the highest order of data package development.

c. F^3 Acquisition Strategies [Ref. 11:p. 6-1]:

Once the decision to use F^3 as a means of second sourcing is made, the program manager must decide how to implement it. There are two possible routes. One is through industry sponsored developments where commercially developed products are used, and the second approach is through Government sponsored development whereby performance specifications are released for contractors to design and develop components.

d. D^3 Acquisition Strategy [Ref. 11:p. 6-1]

According to NAC, there are six possible strategies based on the D^3 approach. These various strategies are discussed more in detail later in this chapter.

3. Stage 1--Competition/Production Considerations

Production competition is not always easy to establish. Prior to FSD and Milestone II, the program manager must ensure that his program is ready to proceed into the next acquisition phase. The following is a list of those requirements which must be met before proceeding [Ref. 11:p. 4-1]:

a. Major design risks must either be resolved or else plans made to resolve them.

b. Firm and realistic performance, cost, and schedule goals must be set.

c. A maintenance concept must be selected.

d. A test and evaluation plan must be set.

e. Adequate funding must be approved and budgeted.

f. System performance requirements must be updated.

g. Limited or pilot production requirements must be established.

h. The acquisition plan must be firmed up.

i. "Fall back" options and alternatives must be identified and reviewed.

The program manager must also ensure that a baseline is established [Ref. 11:p. 4-2]:

a. Engineering development and testing must be done.

b. A limited number of units should be produced for test and evaluation.

c. A Configuration Management Plan should be implemented.

d. An Integrated Logistics Support (ILS) Plan should be developed.

e. The Test and Evaluation Master Plan (TEMP) should be updated.

f. Technical and operational evaluations should be conducted.

g. Production approval should be obtained.

h. The program manager should ensure that there are competitive sources available for his system.

It is also the program manager's responsibility to determine whether or not his program is ready for competition. In making this decision, there are seven characteristics which must be considered and action taken to correct any deficiencies. These characteristics are evaluated through a series of questions [Ref. 11:pp. 4-2--4-5].

a. Market Research--"Has market research identified sufficient industry interest to establish competition?"

b. Technology Availability--"Is the technology planned for the equipment design available as an accepted industry production process?" If the program manager wishes to apply F^3 to a system which is at the leading edge of technology, he may find it difficult to get enough contractors interested who have the resources to design, develop, and produce the system.

c. Stability of Performance Requirements--"Are the performance requirements expected to remain stable after initial production?" For F^3 applications, changes to the system require negotiations with each contractor and their products must be either partially or totally requalified. These changes could have a significant effect on one contractor and not on the other since they have incorporated different technologies into their products.

d. Budgeting for Competition--"Is adequate 'front end' funding available to establish competition?" The use of F^3 requires that adequate funding be available to cover non-recurring costs for tooling, test equipment, R&D,

and qualification. If there are insufficient research, development, test, and evaluation (RDT&E) funds available, the D^3 approach may have to be used. However, if significant quantities are involved, contractors may be encouraged to use their own independent research and development (IR&D) funds.

e. Time/Schedule Constraints--"Is there sufficient time in the schedule to establish production competition to realize a return-on-investment?" Since the F^3 technique requires each contractor to develop his own equipment, the program manager must have a feel for industry's capabilities in his field in order to make rational decisions on how much lead time is needed.

f. Character of Support Resources--"Is there adequate technical support and funding available to implement production competition?"

g. Return-On-Investment (ROI)--"Is a return-on-investment anticipated?"

Lastly, the program manager must make the decision as to whether or not his program is ready for competition. Based on the above factors, the program manager should be able to identify any shortcomings or possible problems and take action to rectify them before proceeding into FSD.

4. Stage 2--Selecting an Acquisition Approach

The F^3/D^3 Decision Model is based on the comparisons made between F^3 and D^3 (Appendix C). To use this model, the following assumptions must be made [Ref. 11:p. 5-3]:

a. Prior to FSD, the production competition decision will be made.

b. Sufficient funding is available.

c. Configuration control of D^3 equipments is maintained by the Government.

d. Prior to using this decision model, a maintenance concept must be chosen.

This model is set up like a flow chart. It asks the program manager several questions which will lead him to the optimum acquisition approach (F^3 of D^3). These questions are [Ref. 11:pp. 5-3--5-8]:

a. Maintenance Concept--"What is the target maintenance concept for the equipment?" And "is the intermediate level Maintenance afloat?" If maintenance is to be conducted by mobile or afloat units, the use of F^3 would be inappropriate since maintenance/supportability would be extremely difficult and expensive unless the reliability was very high.

b. Commercial Developments--"Are there at least two sources of off-the-shelf or modified commercial equipment available that meet the system requirement?" And "can lifetime supportability/availability of the equipment be assured?" If commercial equipments are obtained through F^3 specifications, the program manager must ensure that the contractor will support the equipment throughout its life or else provide adequate technical data so that parts can be obtained from other sources.

c. Funding--"Are sufficient funds available to qualify two or more sources?" If two or more competitive sources are to be established for production purposes, adequate funding must be readily available to support development and qualification costs.

d. Performance Specification--"Can a comprehensive performance specification be developed to the Weapons Replaceable Assembly (WRA) level with a high degree of confidence?" To ensure interchangeability of equipments, all F^3 development and production specifications must be well defined, at least to the WRA level. If these interfaces cannot be defined in adequate detail, F^3 may not be the right approach to use.

5. <u>Stage 3--Selecting an Acquisition Strategy</u>

Once the program manager has chosen an approach, he must decide what strategy to use. To assist the program manager in making this decision, NAC's model uses two aids, the F^3 and the D^3 Competitive Acquisition Strategy Decision Models.

If the program manager decided to use a D^3 approach, he could select from among six alternatives. They are [Ref. 11: p. 6-1]:

a. Industry Lead Strategies

   (1) Contractor Teaming

   (2) Directed Licensing

   (3) Leader Follower

b. Government Lead Strategies

   (1) Performance Specification/Model/Available Data

   (2) Independently Validated Data Package

   (3) Joint Industry-Government Validated Data Package

Should the program manager decide to apply the F^3 approach, there are basically only two variations or strategies that are open to him [Ref. 11:pp. 6-2--6-3]:

a. Industry Sponsored Developments--Under this strategy, the Government utilizes commercially developed equipments. The program manager thereby avoids data rights problems and R&D costs. In theory, this makes good business sense, but the contractor must make certain that the contractor will support the equipment throughout its life and that competition is maintained.

b. Government Sponsored Development--If the Government can specify its requirements in sufficient detail based on the operational needs, physical description, and necessary interfaces, and adequately fund and R&D effort, this strategy can be extremely effective. Once the contractors are qualified, competition should be keen.

In using the F^3 Competitive Acquisition Strategy Model, the program manager must have some knowledge of the market to derive the appropriate strategy. Basically, if the commercial off-the-shelf equipment can be used, or slightly modified for

Government use, and two or more sources who can be motivated to produce the equipment, then the industry sponsored development strategy should be used. On the other hand, if there is no commercial product that can do the job nor contractors willing to fund the development costs and the time frame is critical, then the Government should sponsor the development.

6. Stage 4--Acquisition Strategy Application Guidelines

Now that the program manager has decided on the acquisition strategy, he must minimize the risk to his program by successfully implementing that strategy. The guidelines are rules to follow in order to [Ref. 15:p. 20]:

a. not be caught in a sole source position, and

b. ensure that there will be support throughout the life of the equipment.

D. HOW THE MODELS RELATE TO FORM, FIT, AND FUNCTION

Both the SSMSM and the F^3/D^3 Acquisition Decision Process model may lead a program manager to the same conclusion as to whether or not to use F^3 in his acquisition strategy. They also force a program manager to take a hard look at his program to see where it stands and where it is headed.

The whole of the SSMSM relates to F^3 essentially the same as do Stages 1 and 2 of the F^3/D^3 Acquisition Decision Process model. Several of the same topics are brought up in both models such as maintenance concepts, funding, and lead times.

From there the models change considerably. The SSMSM leaves the decision making up to the program manager based on

the heuristic values applied. The F^3/D^3 Acquisition Decision Process model goes on to identify two variations of the F^3 approach, as discussed in Section C of this chapter. NAC's model then concludes by offering some guidelines to apply in the application of F^3.

E. SUMMARY

The intent of this chapter was to expose the reader to two current second sourcing selection models and relate them to the F^3 concept to determine how they approach the F^3 as a means to second source an item. The following chapter reviews two programs which were second sourced using F^3 as an acquisition strategy.

V. A REVIEW OF FORM, FIT, AND FUNCTION APPLICATIONS

The purpose of this chapter is to examine how the F^3 approach has been used in actual applications and to discuss why it was chosen over the other second sourcing applications. The programs reviewed were the Low Cost Sonobuoys and the Standard Central Air Data Computer.

A. LOW COST SONOBUOYS

1. General

Low Cost Sonobuoys (LCS) are just one element of the low cost sonobuoy system (LCSS). The complete system consists of the LCSs, sonobuoy launch containers, avionics for P-3 and S-3 aircraft, sonobuoy launchers, and advanced broadband sensor development. The purpose of the system is to provide effective, economical airborne antisubmarine warfare detection against existing and future submarine threats. Unless otherwise referenced, the material in this section was based on the acquisition strategies for LCS.

2. Program Background and Acquisition History

In 1983, a Request for Proposal (RFP) was released which stipulated that there would be a two-phased R&D effort involved for the development of the sonobuoys. In September 1983, six offerors were awarded firm fixed-price (FFP) contracts, based on their technical approach, granting them a three month design study effort (Phase I). Phase II was

to result in a twenty-one month exploratory development effort and was eventually awarded to two of the six original offerors. For this effort, cost plus reimbursement type (CPFF) contracts with a 50/50 share on cost overruns were used for the fabrication, delivery, test, and evaluation of 250 complete LCSs from each source. The Phase II contracts were awarded to Sippican Ocean Systems,Inc. and Spartan Corporation.

The source selection criteria for this program were based on:

a. technical approach,

b. technical risk,

c. design-to-cost,

d. contractor experience/facilities/management, and

e. development cost realism/reasonableness.

Along with LCS contracts, both Sippican and Spartan were given cost-plus-fixed-fee (CPFF) contracts to develop shipping-launching containers based on a performance specification designed around their versions of the LCS. These containers were not competitively awarded since it is customary that the company manufacturing the sonobuoy, also manufacture the container. In addition, competitively awarding the container at this time would add unnecessary risk and time delay to the program.

Delivery of the LCSs is planned to increase in a gradual manner from 20,000 units to 500,000 units over a period of three years. The proposed delivery schedule is as follows:

Pilot Production LCSs 3rd Qtr FY-86--2nd Qtr FY-87
20,000 (10,000 each contractor)

Production LCSs 3rd Qtr FY-87--2nd Qtr FY-88
100,000 (50,000 each contractor)

Production LCSs 3rd Qtr FY-88--2nd Qtr FY-89
500,000 (one or two contractors)

Based on the Chief of Naval Operations Executive Board's (CEB) decision of 21 March 1985, both Sippican and Spartan began pilot production. Under the fixed-price incentive (FPI) type contract, the assembly of the LCSs required that a semi-automated facility be used. Both manufacturers were required by the Secretary of the Navy (SECNAV) to become fully automated. The purpose of this was to achieve a low unit cost and a high level of reliability [Ref. 32]. These units were to be used for technical and operational testing and to ensure an early introduction into the fleet.

3. Acquisition Strategy

LCSs were designed to be non-maintainable, non-repairable, expendable items for which no spare parts or maintenance test facilities were required. Because of this maintenance philosophy, the LCS acquisition is based on a performance specification.

There were two secondary reasons for using a performance specification, or F^3 approach, in this situation. One was to take advantage of innovative design developments to achieve cost reductions. A related point was that the technology in this field had been changing so rapidly that manufacturers were altering the configuration of their sonobuoys

approximately every three years as long as there were no changes to the performance specification [Ref. 33]. This fact would make the purchase of a technical data package very uneconomical.

The second reason for using F^3 was that the need to introduce the LCS into fleet use was of utmost importance and waiting for further technological advances was not an option. By using F^3 to realize later performance and capability improvements as developments continued, the program manager was not faced with upfront schedule versus cost or performance trade-offs.

The decision to second source was made in order to ensure an adequate industrial base would be present to meet surge and mobilization requirements. Peacetime needs were expected to average one-half million LCSs per year. A split-buy award method was used with a larger share going to the lowest bidder. Only two contractors were awarded contracts for pilot production units since it was deemed that more than two sources would be inefficient, particularly since the overall system concept was not yet fully validated.

In support of this purchase, Level II engineering drawings would be purchased in accordance with MIL-D-1000. Since F^3 was utilized, perceivably throughout the life of the LCS program, Level III drawings did not have to be purchased for later reprocurement use. The Level II drawings were to be used for lot acceptance and production surveillance purposes.

4. Benefits of the Program

In reviewing the LCS program, the researcher considered the following benefits to be important to the program [Ref. 32]:

a. The LCS program has met its goal so far in ensuring that an adequate industrial base exists. The benefit of reduced price has also been realized because of the competitive nature of the program.

b. There have been no problems to date with the program. This may be partly due to the fact that sonobuoys have historically been purchased via a performance specification and never with a design specification.

c. As contractors get their automated production lines operational, quality and price should both improve.

5. Analysis of the Form, Fit, and Function Application

In analyzing the LCS acquisition, it becomes evident that the LCS program is a classical application of the F^3 methodology. To begin, there was a substantial amount of interest by industry in the program which is important to any second sourcing effort. Much of this interest was created by the long duration of the program and large quantities of LCSs required to incentivise contractors to expend IR&D funds and be willing to invest in tooling and production facilities.

The technical complexity of the sonobuoys was such that, though the LSCs were state-of-the-art, there were no complex interfaces with which the contractor had to be concerned. Additionally, there was no need to transfer data between contractors since each manufacturer had to build from his own design.

One of the goals of the program was to field the system as soon as possible, then let technical advances increase the performance of the sonobuoys as the program matured. The F^3 technique was ideal in this situation since it allowed for continued technological advancements but also allowed the system to be fielded using the technology currently available. If the procurement would have been made using a design specification, the design would have had to have been frozen, otherwise the cost of buying a technical data package and validating it would be a wasted expense.

Of prime importance was the maintenance concept which was selected. For the LCS program, there was to be no maintenance conducted on the sonobuoys at any level which precluded requirements for spare parts and support facilities. Therefore, there was no concern over the internal configuration of the LCSs and the contractors could incorporate any design or technology into the LCSs which was compatible with their engineering and production capabilities. This in turn could help to achieve lower prices if the contractors were using their own proven methods and facilities to produce the item.

In the procurement of any system or component, a good specification is essential to ensure that what was ordered was what was required and received. In the case of the LCSs, the use of a performance specification was wise because good specifications could be prepared. The interfaces were relatively simple and could be easily documented. In addition, the purchase

of sonobuoys had always been made under performance specifications. Because of this past experience, the Government engineers could safely ensure that the specifications they prepared would be complete and accurate.

B. STANDARD CENTRAL AIR DATA COMPUTER

1. General

The Standard Central Air Data Computer (SCADC) is a new state-of-the-art, solid state air data computer. It is to be used as a retrofit for the currently installed systems aboard several airframes in the Navy and Air Force arsenals. The current systems are electromechanical analog devices which have exhibited low reliability and costly maintenance characteristics. Because of the outdated technology of the present systems, spare parts and production line support are waning.

This is a joint Navy/Air Force program for which the Air Force is the lead agency. The SCADCs are to be used on both tactical and non-tactical aircraft within both Services. Because there are several air frames involved, there were several different configurations of the SCADC developed to meet the required form, fit, and function parameters.

One standardization feature of these computers is the use of a common core module which includes the power supply, microprocessor, memory, and transducers [Ref. 34]. The core accounts for approximately 88% of the hardware commonality between the various configurations of each contractor [Ref. 34]. Another standardization feature is that of compatible

software [Ref. 35]. Unless otherwise referenced, the material in this section was based on the acquisition strategy for the SCADC.

2. Program Background and Acquisition History

The development of the SCADC was to be designed around a form, fit, and function specification which would allow it to be applied to several weapon systems and still realize life cycle cost (LCC) benefits of standardization. The objective of the program was to replace the older air data computers with a new state-of-the-art model. The SCADC was expected to improve performance in addition to improving reliability, maintainability, and interoperability. Total LCC management was an integral part of the program and all changes requested by the contractors required trade-off studies be made to assess LCC impacts.

In April 1981, a RFP for development was issued and contracts were awarded to two companies in September 1981. The two companies were Garrett AiResearch Manufacturing Company of Torrance, California and Marconi Avionics Limited (now General Electric Corporation) of Kent, England.

The risk factors concerning the SCADC were generally low. Since the technology currently existed, technical risk was seen to be low. General Electric Corporation (GEC) had already completed the required Reliability Qualification Testing (RQT) and Garrett was expected to qualify prior to the contract award for production. Cost risk was also low since the

field was very competitive and each contractor had already built 108 units from which to draw accurate cost data. Schedule and manufacturing risk were also considered low since production techniques were already proven. However, schedule risk could slip to moderate if Garrett could not pass RQT prior to production award date.

The reason for this possible slippage was that Garrett was experiencing quality problems. Garrett had received an unfavorable result on a Quality System Review which gave them a moderate risk for quality assurance. GEC was still regarded as having a low quality assurance risk since they had already passed QRT.

Purchase of the various configurations was expected to be spread over several years as follows:

	Basic FY-85	Option FY-85	Option FY-86	Option FY-86	Option FY-88	Option FY-89
Air Force	574	518	1015	971	150	79
Navy	298	49	426	355	0	0
Options (AF/Navy)	0	197	228	640	688	522
Totals	872	764	1669	1966	838	601

Total Programmed Requirements	4,425	\$202.0M
Total Optional Planning (AF/Navy)	2,275	94.6M
	6,710	\$296.6M

Source selection was based on an overall assessment of technical, life cycle cost, and management considerations. The assessment of management included a review of the risk factor for not having completed the RQT.

Both Services decided that a two-level maintenance concept was the most cost effective method of maintenance for these units. The units were to be covered for three years under the contractor's warranty after which time the Services would assume organic repair at the depot level. Even though GEC planned to build their products in England, repair would be effected at their plant in Georgia [Ref. 18]. Interestingly, the SCADC units had been designed to accommodate intermediate level maintenance as well as organizational and depot level by using built-in-test (BIT) capabilities which allowed fault isolation down to the systems replaceable assembly (SRA) or module level [Ref. 34].

On 21 June 1985, the production award was made [Ref. 36]. It was expected that these two companies would be the only competitors for the production contracts due to schedule constraints. It was also anticipated that there would be a split award to both Garrett and GEC for production of the SCADCs. Even though Garrett had not yet qualified due to reliability and quality problems, it was felt that they could be qualified [Ref. 36]. However, when the Source Selection Authority (SSA) made the final decision, only GEC was awarded a contract. His decision was based primarily on price since there was a considerable difference between the two competitors [Ref. 36].

The program is currently in a sole source position. Level III drawings for reprocurement will be purchased.

However, Garrett may yet become qualified and reprocurement using F^3 for future follow-on purchases has not been ruled out [Ref. 36].

3. Acquisition Strategy

The best acquisition strategy for the procurement of the SCADC was determined to be F^3 for two reasons. One is that the efforts and knowledge of industry could be applied to the program [Ref. 36]. Secondly, since the focus of the program was to retrofit existing airframes, there was no TDP available to use as a source document. The contractors were therefore required to do the development and they assumed the risk of ensuring that their products met the specifications in the solicitation package [Ref. 18].

The purpose of the second sourcing effort for SCADC was to try to reduce price [Ref. 36]. As stated above, LCC considerations were very important for this program. This consideration came up repeatedly throughout both the acquisition strategy and from personal interviews.

4. Benefits of the Program

In reviewing the SCADC program, the researcher considered the following benefits important:

a. Even though a split buy was possible, and even anticipated, organic repair was to be used at the depot level. It had been determined that the extra expense of supporting two different manufacturer's products would be overcome by the competition over price and also the fact that there were no major differences in the construction of the different variations. [Ref. 18]

b. Substantial cost savings were in fact realized. [Ref. 37]

c. The performance specifications used for the acquisition were well-prepared. There were a few minor modifications made to the equipments being retrofitted that required changes to the specifications, however the modifications were slight and easily resolved. [Ref. 36]

5. Analysis of the Form, Fit, and Function Application

In analyzing the SCADC program, there were many significant differences in the application of the F^3 second sourcing methodology between this program and the LCS program. While a large number of SCADCs were being procured in the first year, there was no guarantee that large sales in the follow-on years would materialize even though the options indicated that they could. This point could have a negative impact on the number of competitors who would be willing to expend IR&D funds to even submit a proposal.

The major difference between the two programs centers around the adopted maintenance concept. Essentially, the SCADC was a repairable item while the LCS was a maintenance-free, expendable item. Once the contractor's three year warranty expired, repair was to transfer to organic facilities. Both Services decided to use a two echelon maintenance plan since it was conceivable that several configurations of the SCADC might have to be supported. Because of multiple configurations, repair parts, test equipment, repair data, and personnel training would be needed to support the maintenance plan. This is somewhat in conflict with the idea that if an item is to be repaired organically, then the configurations should be identical, i.e., buy with a design specification vice

a performance specification. However, in this case, the Services decided that the dollars saved from competition would more than offset the added support costs.

This carries over into another important point. The decision had been made that once these computers were initially purchased, follow-on buys would be made using a technical data package approach so that later SCADCs would be identical to the original ones, regardless of who would build them. This will result in purchasing and validating the data packages so that the technology can be transferred to other sources.

Because two different manufacturers were awarded contracts to develop their computers, they would both have to be qualified. This was good in that it puts the burden on the contractor to qualify his product and not on the Government to provide adequate design specifications. However, much effort has gone into trying to qualify the one contractor with no success. Even though the goal of reducing price had been achieved, the program was put into a sole source position until either the other contractor becomes qualified, reprocurement data is made available for use in solicitations, or another contractor could produce the item using the performance specifications.

Since the interface for the SCADCs are much more complex than the LCSs, great care had to be taken to ensure that all of the interfaces had been properly identified and accurately described. The Government engineers were aided in that they

were dealing with fairly stable airframes and were aware of the interfaces. A potential problem did arise when there were some modifications made to the equipment with which the SCADCs would interface. Fortunately, the modifications were slight and the contractors could respond easily. The problem could have had a substantial impact on one or both of the contractors if major changes to the computer would have been necessitated because of the particular design or technology used.

C. SUMMARY

This chapter presented two case studies of purchases using Form, Fit, and Function as an acquisition strategy and analyzed how they fit into the F^3 concept. Both cases have so far realized their goals even though they are still in the early stages of their life cycles. They have also demonstrated that Form, Fit, and Function can be a viable alternative in the second sourcing decision.

VI. CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the researcher presents several conclusions and recommendations based on this research effort. While the reader may or may not agree with all of these conclusions and recommendations, the researcher believes that the general opinions of the major system acquisition community are properly expressed.

A. CONCLUSIONS

Based on this study of Form, Fit, and Function, the following conclusions were drawn:

Conclusion #1. Form, Fit, and Function will most likely never be used as a second sourcing methodology for an entire major weapon system for reprocurement purposes.

The consensus of those interviewed expressed the viewpoint that F^3 is not an appropriate methodology for second sourcing an entire major weapon system once an initial procurement has been made. This concept was discussed in the elements and attributes section of Chapter III. Because of the additional costs of using F^3 for acquisition purposes, uncertain development lead time, and particularly, logistic support problems, F^3 lends itself more readily to the procurement of the components of a system rather than the complex system itself.

Conclusion #2. The major determination regarding the viability of F^3 as a second sourcing methodology centers around the selected maintenance concept.

A major concern for any weapon system is the supportability of the system once it is fielded. Since F^3, by design, encourages different internal configurations of a component, supportability by afloat and field units would become more difficult and costly should F^3 be used. This problem is more actue in the Navy which relies more heavily on three levels of maintenance than the Air Force which is relying more and more on two levels of maintenance.

Conclusion #3. In order for performance specifications to be useful in a Form, Fit, and Function application, the design of the system and interface requirements should be fairly firm.

As discussed in Chapters III and IV, the design of the system should be fairly stable in order for performance specifications to be properly prepared. Physical and interface requirements are critical to an F^3 acquisition and must therefore be relatively certain. Changes can be made to performance specifications, however there is a chance that some contractors may become noncompetitive if the technology or design which they are using is not compatible with the change.

Conclusion #4. Form, Fit, and Function can be an extremely capable and effective acquisition tool when the transfer of technology between sources is not essential or possible.

F^3 has several attributes that can make it extremely attractive to a program manager when the transfer of technology is not required. As discussed throughout Chapter III, the features of F^3 are such that:

a. F^3 can allow a program manager to get around data rights problems.

b. It can also be a means of working around an uncooperative contractor.

c. Since each contractor is responsible for both design and production, much of the risk is taken off the Government and placed on the contractor.

d. If the intent of the program manager is to continue to use F^3 for the reprocurement of the item, both design and production competition may be able to be realized throughout the life of the item.

e. Since the contractor may be utilizing his own design and production capabilities, he may be able to operate more efficiently and thus realize a lower cost than if he had to manufacture to a design specification.

f. The production process used by a contractor may be unique to that contractor and may not be able to be duplicated by another contractor. In this case, F^3 could be used to get other sources of supply when the transfer of technology is not possible.

Conclusion #5. Good performance specifications are essential to the successful application of the Form, Fit, and Function methodology.

The quality and completeness of the specification must be excellent if the procurement is to be a successful one. As discussed in the performance specification section of Chapter III and in the F^3/D^3 Acquisition Decision Process model in Chapter IV, an adequate specification is of utmost importance. The end product will be only as good as the specifications to which it was designed.

B. RECOMMENDATIONS

Recommendation #1. The F^3/D^3 Acquisition Decision Process should be expanded to include post production buys.

Post production is a very important area that needs to be addressed. With the continued emphasis on competition for price and quality, and problems with a shrinking industrial base, this area should not be neglected. NAC should take the lead and proceed to develop this model to include this very important area.

Recommendation #2. Program managers must plan early in the acquisition cycle in order for a Form, Fit, and Function second sourcing strategy to be effective.

Program success relies heavily on early program manager planning if multiple sources are to be used to meet established goals for the system. A sufficient budget must be available for supporting an F^3 second sourcing effort to cover such additional expenses as development costs and contractor qualification costs for more than one contractor. The program manager must also ensure that adequate time is allotted to give the contractors sufficient time to research and develop their products. Program managers should ensure that, if F^3 is to be used, necessary measures are taken early in the acquisition cycle to allow time for budgeting to be programmed and design development to be accomplished.

Recommendation #4. Program managers should ensure that the maintenance concept to be used is firmly decided before

the decision to use Form, Fit, and Function as a second sourcing methodology is made.

The desired level of maintenance is a critical element in determining whether or not F^3 is a viable second sourcing methodology. There is a direct correlation between the level of maintenance and the amount of supportability that a given weapon system will require. Because of this, program managers should ensure that they have a set maintenance policy prior to using F^3. They should also ensure that the decision to use F^3 is consistent with that particular maintenance policy.

Recommendation #5. The program manager should ensure that the design and interface requirements of the system are stable before performance specifications are released for procurement purposes.

Changing specifications can have an extremely detrimental effect on procurements using F^3 as the second sourcing methodology. Design and development expenses can increase, development times can multiply, and the uncertain effects that it may cause the various competitors are potential problems that may be associated with a change in the specifications. Program managers should be aware of these possible problems and strive to either freeze the design or at least limit changes to only those that are absolutely required.

C. ANSWERS TO RESEARCH QUESTIONS

1. <u>What are the main attributes of the Form, Fit, and Function concept?</u>

There were many attributes of F^3 discussed in Chapters II, III, and IV. The main attributes were:

a. It allows the user a maximum of flexibility in selecting from proposed technologies. As RADM Platt stated, it "leaves the option open to take a bargain." [Ref. 32]

b. The risk of performance is in the hands of industry vice the Government to ensure that the product can meet the performance requirements set forth in the solicitation.

c. Since there is no transfer of technology, the program manager is not dependent upon the cooperation of the original developer or technical data for reprocurement purposes.

d. Overall, performance specifications are easier to prepare than design specifications.

2. <u>How might this approach be successfully employed as a second sourcing methodology?</u>

F^3 can be used successfully in the acquisition of both simple, expendable items and extremely complex and highly technical components. As noted in Chapter III, due to multiple configurations inherent in the F^3 approach, the acquisition of entire major weapon systems on a whole may be precluded after the initial buy. This may also hold true for components which would require repair by afloat or mobile units.

3. <u>What is the Form, Fit, and Function concept?</u>

This question is fully addressed in Chapters II and III of this thesis. F^3 is essentially a second sourcing technique

that requires a manufacturer to design and build his own product rather than build to a preestablished design. The sources are, therefore, building to a performance specification rather than a design specification.

4. <u>How does Form, Fit, and Function relate to the other methodologies?</u>

As discussed in Chapter III, F^3 is a more truly competitive second sourcing methodology than the other methodologies because it pits one contractor against another based on both design and production competition. The F^3 technique is totally different from the other methods because there is no transfer of technology between competing firms. Each produce is redesigned based on the individual contractors' engineering and production capabilities. Also, unlike the other methodologies, there is no control over the internal configuration of each product. This results in these items being functionally, but not logistically, interchangeable. These differences become readily apparent when using the F^3/D^3 Acquisition Decision Process model discussed in Chapter IV.

5. <u>What are the significant factors for the use of Form, Fit, and Function?</u>

As discussed in Chapter III, there are two major decisions which must be made before the determination to use F^3 should be made. One is that the maintenance plan must be set. If the maintenance plan calls for organizational level repair or intermediate level repair afloat, F^3 may be inappropriate to

use. Another significant factor is that a good performance specification must be available and all interfaces well documented.

6. <u>What have been the significant issues or problems raised with the second sourcing of Low Cost Sonobuoys and the Standard Central Air Data Computer</u>?

The sonobuoy program has been very successful in both terms of increasing the industrial base and decreasing the unit price. In order to remain competitive, the contractors have kept improving the technology used. Changes to the program have proven to be disruptive to the technical advancements of the contractors.

The Standard Central Air Data Computer has been successful in reducing unit cost. The major problem in the program has been trying to get both contractors' computers qualified. One contractor is still not qualified. Until both sources can get certified, the program is in a sole source position. Another important fact was that it had been decided that it would be cost effective to organically repair various configurations of the SCADC rather than use contractor support.

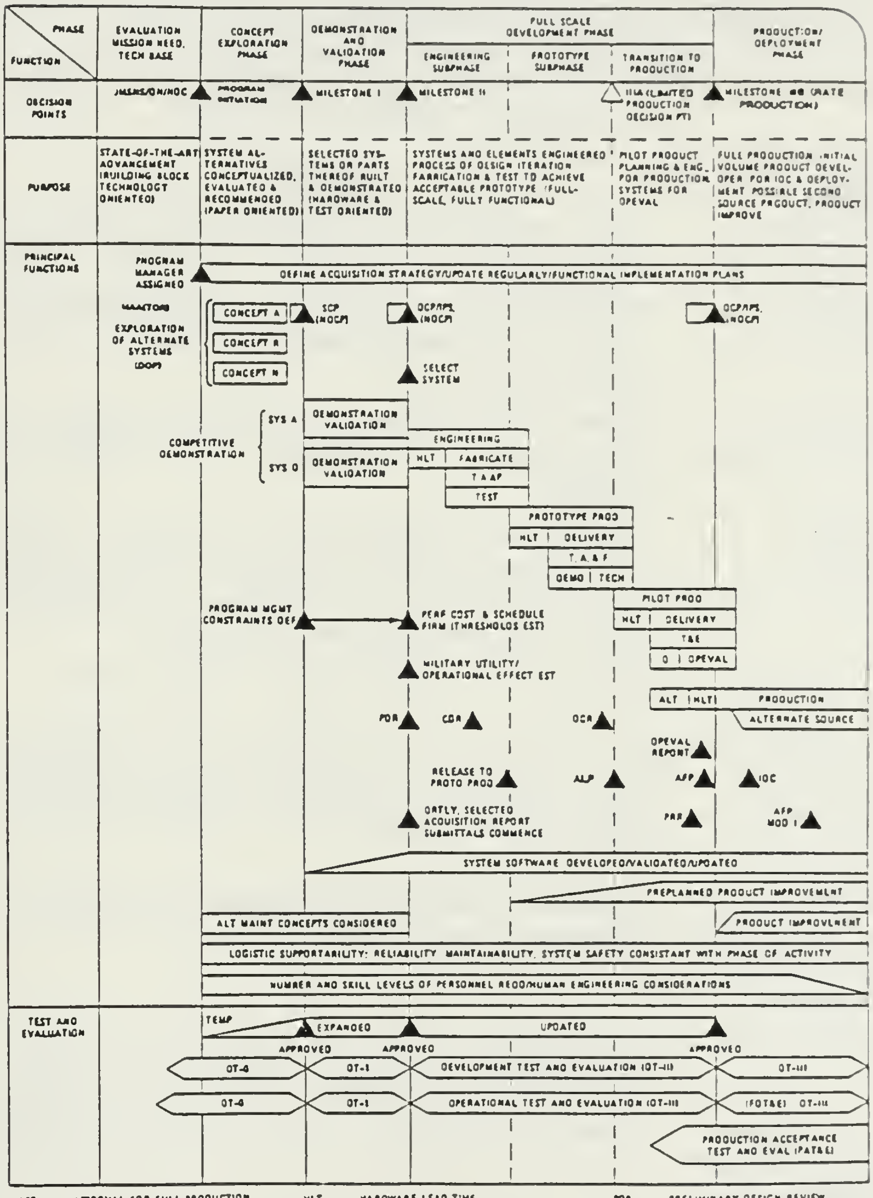
D. AREAS REQUIRING FURTHER RESEARCH

Upon completion of this research effort, one area seems to need additional research to be more fully addressed. This area, which would be interesting to research, woulc be to take the two models discussed in Chapter IV and apply them to various programs already completed and some in the early

stages of the acquisition process, to see how well the models lend themselves to assisting the program manager in making second sourcing decisions.

APPENDIX A

MAJOR SYSTEMS ACQUISITION PROCESS



AFP – APPROVAL FOR FULL PRODUCTION
ALP – APPROVAL FOR LIMITED PRODUCTION
ALT – ADMINISTRATIVE LEAD TIME
CDR – CRITICAL DESIGN REVIEW
DCP/IPS – DECISION COORDINATED PAPER/ INTEGRATED PROGRAM SUMMARY
DCR – DESIGN CERTIFICATION REVIEW
HLT – HARDWARE LEAD TIME
IOC – INITIAL OPERATIONAL CAPABILITY
JMSNS – JUSTIFICATION FOR MAJOR SYSTEM NEW START
MND – MISSION NEED DETERMINATION
NDCP – NAVY DECISION COORD PAPER (FOR LESS THAN MAJOR PROGRAMS)
PDR – PRELIMINARY DESIGN REVIEW
PRR – PRODUCTION READINESS REVIEW
Q – PRODUCT QUALIFICATION
T, A, & F – TEST, ANALYZE AND FIX
TEMP – TEST AND EVALUATION MASTER PLAN

APPENDIX B

SECOND SOURCING METHOD SELECTION MODEL

SUMMARY OF DECISION VARIABLES AFFECTING SELECTION OF A SECOND SOURCING METHOD

Variable	Effect
Quantity of Production	Low quantities make second sourcing difficult, especially for technical data package.
Duration of Production	Qualifying a second source takes time. Licensing and leader-follower are particularly unsuitable.
Slope of Learning Curve	When steep learning is involved, any split of production quantities will tend to increase costs.
Technical Complexity	The more complex the system, the more difficult it is to second source. Contractor teaming is especially effective in bringing complementary technologies together.
State-of-the-Art	Similar to technical complexity.
Other Government and Commercial Applications	If there are significant alternative uses for the system, original producer will probably create barriers to second sourcing.
Degree of Privately Funded Research and Development	Second sourcing success limited if critical elements are proprietary.
Special Tooling Costs	Provides original producer strong competitive advantage if costs are very high.
Cost of Transferring Unique Government-Owned Tooling	Equal weighting for all alternatives.
Capacity of the Developer/ Original Producer	The more capacity the original producer has, the less likely second sourcing can be effective.
Maintenance Requirements	If second sourcing introduces variations in field maintenance, its viability decreases.

Production Lead Time	The longer the lead time, the smaller the advantages of second sourcing.
Degree of Subcontracting	If many subcontractors are involved, the advantages of second sourcing are diluted.
Contractual Complexity	The more complex the contractual relationship with the original producer, the more barriers there are to second sourcing.

SECOND SOURCING METHOD SELECTION MODEL: FIRST PRODUCTION

Variables	Methodology: Form-Fit-Function	Technical Data Package	Directed Licensing	Leader-Follower	Contractor Team
Quantity					
High	+	+	+	+	+
Medium	+	+	0	0	+
Low	0	0	-	-	0
Duration					
Long	+	+	+	+	+
Medium	+	+	0	+	+
Short	0	0	x	x	0
Learning Curve					
Steep	-	-	-	0	0
Flat	+	+	+	+	+
Technical Complexity					
High	0	x	+	+	+
Medium	+	-	+	+	+
Low	+	+	+	+	+
State of the Art					
Yes	0	x	+	+	*
No	+	+	+	+	+
Other Application					
Yes	+	0	+	0	+
No	+	+	+	+	+
Degree of Private R&D					
High	0	x	0	x	-
Low	+	0	+	+	+

Key:

+ = Strong applicability
- = Weak applicability
* = Particularly well suited
0 = Neutral applicability
x = Particularly inappropriate

Variables	Methodology				
	Form-Fit-Function	Technical Data Package	Directed Licensing	Leader-Follower	Contractor Team
Tooling Costs					
High	-	-	-	-	x
Low	+	+	+	+	+
Government Tool Transfer Cost					
High	0	0	0	0	0
Low	+	+	+	+	+
Contractor Capacity					
Excess	-	-	-	-	-
Deficient	+	+	+	+	+
Maintenance Requirement					
Significant	x	0	0	0	0
Minimal	+	+	+	+	+
Production Lead Time					
Long	-	-	-	-	-
Short	+	+	+	+	+
Degree of Subcontracting					
Heavy	0	-	-	-	-
Light	+	+	+	+	+
Contractor Complexity					
Complex	-	-	-	-	-
Simple	+	+	+	+	+

Key:

+ = Strong applicability
-= Weak applicability
0 = Neutral applicability
x = Particularly inappropriate

SECOND SOURCING METHOD SELECTION MODEL: REPROCUREMENT

Variables	Methodology: Form-Fit-Function	Technical Data Package	Directed Licensing	Leader-Follower	Contractor Team
Quantity					
High	+	+	+	+	+
Medium	+	0	0	0	+
Low	0	x	-	-	-
Duration					
Long	+	+	+	+	+
Medium	+	0	0	0	0
Short	0	x	x	x	-
Learning Curve					
Steep	0	0	0	0	0
Flat	+	+	+	+	+
Technical Complexity					
High	0	x	+	+	*
Medium	+	-	+	+	+
Low	+	+	+	+	+
State of the Art					
Yes	0	x	+	+	*
No	+	+	+	+	+
Other Application					
Yes	+	-	+	0	+
No	+	0	+	+	+
Degree of Private R&D					
High	0	x	0	x	0
Low	+	0	+	+	+

Key:

+ = Strong applicability
- = Weak applicability
* = Particularly well suited
0 = Neutral applicability
x = Particularly inappropriate

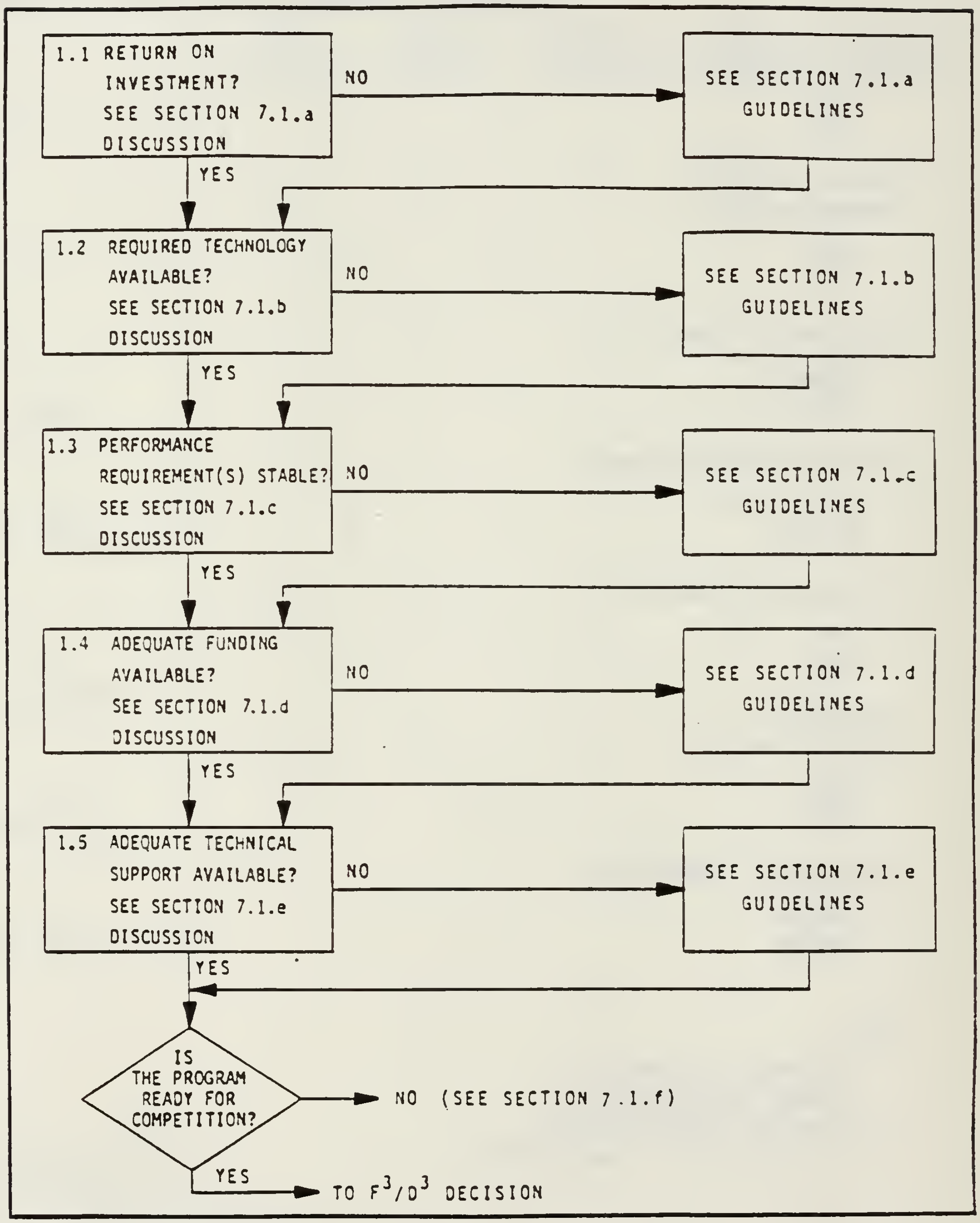
Variables	Methodology				
	Form-Fit-Function	Technical Data Package	Directed Licensing	Leader-Follower	Contractor Team
Tooling Costs					
High	-	-	-	-	x
Low	+	+	+	+	+
Government Tool Transfer Cost					
High	0	0	0	0	0
Low	+	+	+	+	+
Contractor Capacity					
Excess	-	-	-	-	-
Deficient	+	+	+	+	+
Maintenance Requirement					
Significant	x	0	0	0	0
Minimal	+	+	+	+	+
Production Lead Time					
Long	-	-	-	-	-
Short	+	+	+	+	+
Degree of Subcontracting					
Heavy	0	-	-	-	-
Light	+	+	+	+	+
Contractor Complexity					
Complex	-	-	-	-	-
Simple	+	+	+	+	+

Key:

\+ = Strong applicability
\- = Weak applicability
0 = Neutral applicability
x = Particularly inappropriate

APPENDIX C

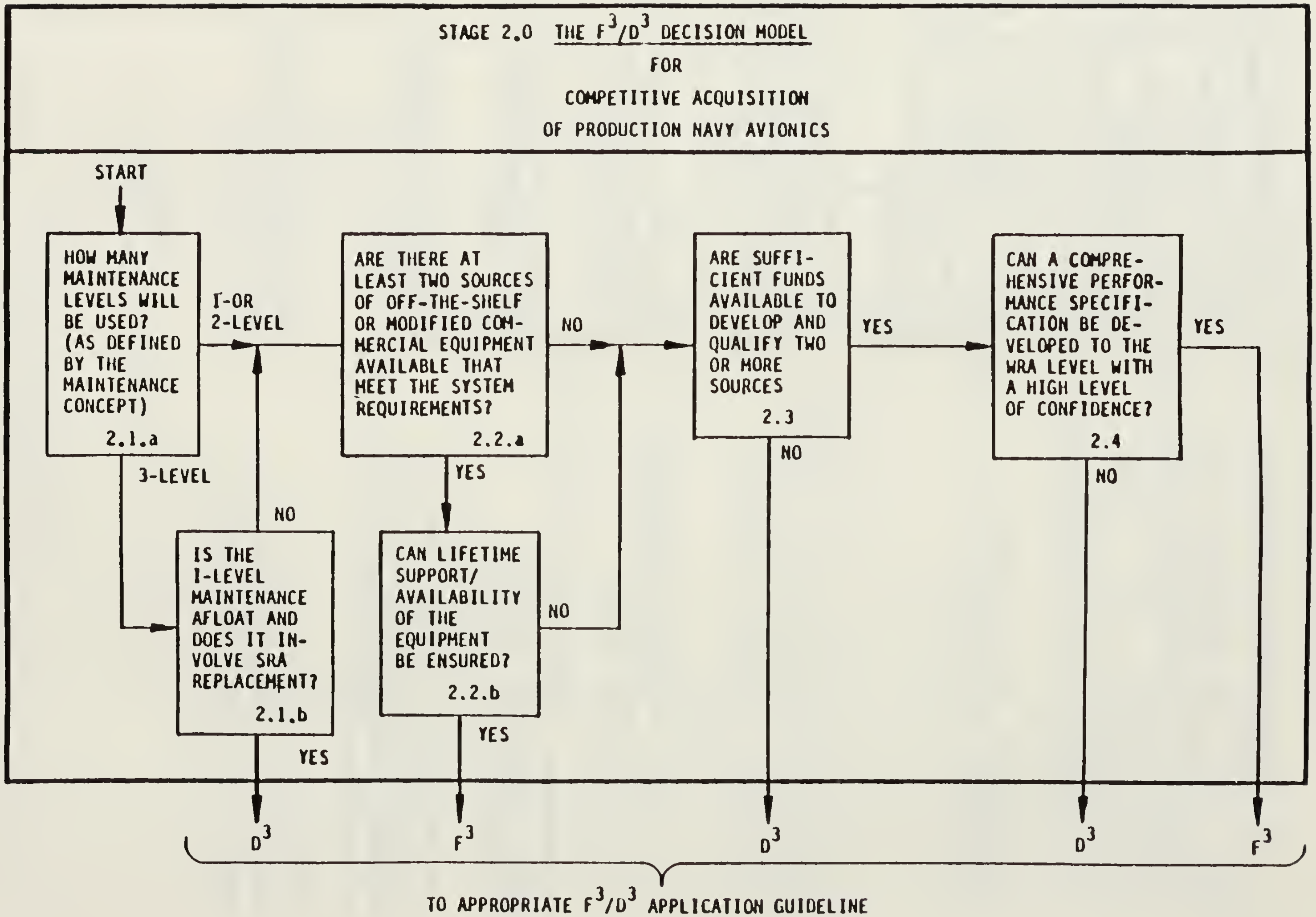
F^3/D^3 ACQUISITION DECISION PROCESS



COMPETITION/PRODUCTION CONSIDERATIONS (STAGE 1.0)

Comparative Summary of the F^3 and D^3 Acquisition Approaches

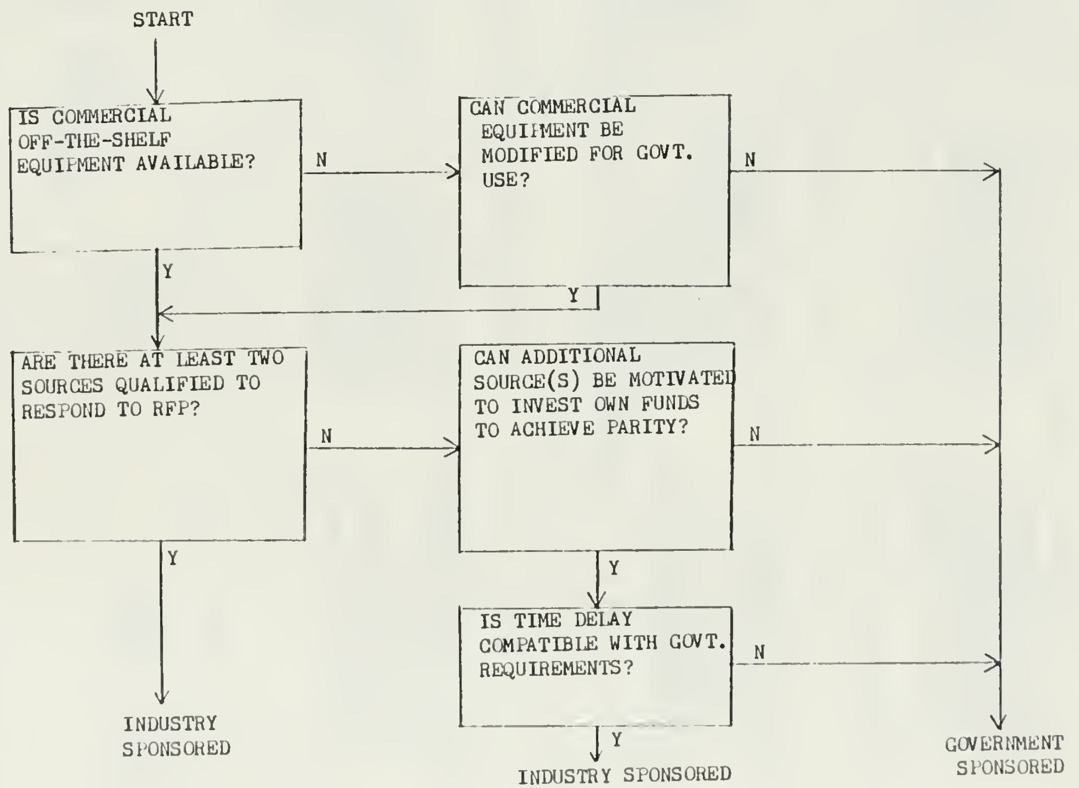
F^3 Acquisition Approach	D^3 Acquisition Approach
Form, Fit, and Function only ensures interchangeability at the WRA level. Internal configurations may vary. WRAs are functionally but not logistically interchangeable.	D^3 ensures interchangeability at the WRA, SRA, and piece part levels. Internal configurations are identical. WRAs and SRAs are functionally and logistically interchangeable.
Development of multiple suppliers' equipment in parallel is required.	Design competition between competing FSD contractors is encouraged but single source development of equipment is permissible.
If compliance with the system/WRA specification can be demonstrated, the contractor is authorized to make internal design changes.	The contractor must obtain Navy approval for all design changes. Government retains configuration control during full production.
Contractor assumes responsibility for adequacy of design and production data.	Government assumes responsibility for adequacy of design and production data.
Government buys maintenance data only when organic maintenance is planned.	Government buys the Technical Data Package (TDP) and the data rights.
The equipment specification is validated through the contractor and Government test and validation.	The TDP is validated by an independent source.
Production competition is achieved through continuing competition between/among the development contractors.	Competitive production sources are established using the validated TDP.



THE F^3/D^3 DECISION MODEL

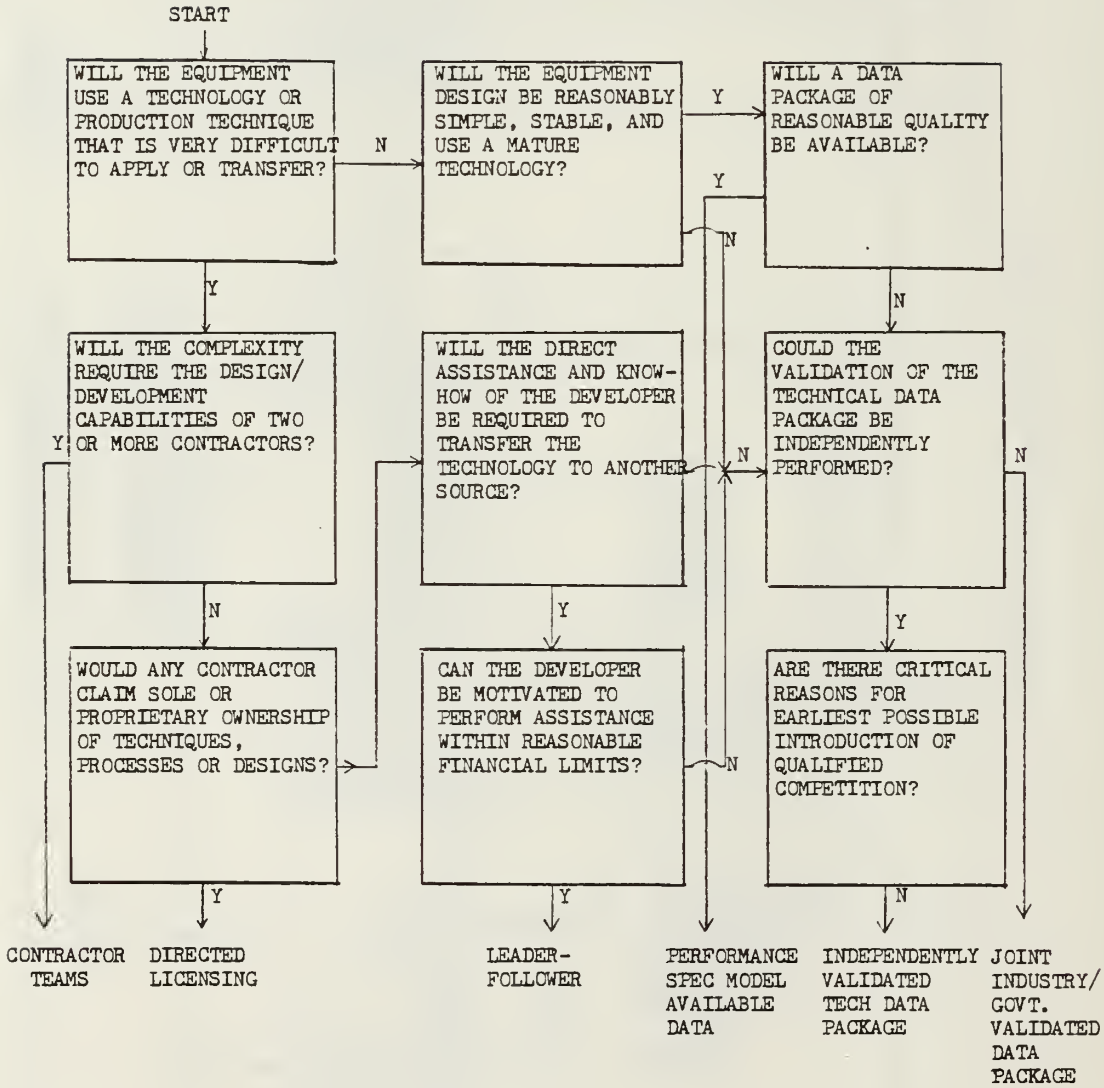
STAGE 3

F^3 COMPETITIVE ACQUISITION STRATEGY DECISION MODEL



STAGE 3

D^3 COMPETITIVE ACQUISITION STRATEGY DECISION MODEL



STAGE 4
APPLICATION GUIDELINES
F^3 PERFORMANCE SPECIFICATION

INFORM ALL POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO OBTAIN MORE THAN ONE QUALIFIED DESIGN/PRODUCER.

PREPARE A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION FOR EACH WRA IN THE SYSTEM.

RETAIN OPTION TO PURCHASE DATA/DATA RIGHTS IN ALL FSD AND PRODUCTION RFP'S.

INCLUDE DATA/DATA RIGHTS OPTION (NOT-TO-EXCEED) IN SOURCE SELECTION CRITERIA.

PURCHASE MAINTENANCE ITEMS NEEDED TO SUPPORT PLANNED MAINTENANCE CONCEPT.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PURCHASE DATA FOR A PARTS TRACEABILITY PROGRAM.

INCLUDE CLAUSE IN ALL CONTRACTS GUARANTEEING LIFETIME SUPPORTABILITY/AVAILABILITY.

DEVELOP FALL-BACK STRATEGIES IN THE EVENT F^3 PROGRAM REVERTS TO ONE CONTRACTOR.

STAGE 4
APPLICATION GUIDELINES
D^3 CONTRACTOR TEAMING

INFORM ALL POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO DEVELOP AND FACILITIZE TWO OR MORE PRODUCERS.

PREPARE A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION TO THE SYSTEM LEVEL.

STRUCTURE THE FSD RFP AND ESTABLISH SOURCE SELECTION CRITERIA TO GUARANTEE THAT BOTH CONTRACTORS OF THE SELECTED TEAM WILL EVENTUALLY BE CAPABLE OF INDEPENDENT PRODUCTION.

SEEK LEGAL COUNSEL BEFORE PLACING FSD CONTRACTS TO DETERMINE IF ANTITRUST PROBLEMS MIGHT EXIST.

PROHIBIT THE USE OF PROPRIETARY AND/OR SOLE SOURCE PARTS.

RETAIN THE OPTION TO PURCHASE THE TECHNICAL DATA PACKAGE AND DATA RIGHTS AND INCLUDE THIS OPTION (NOT-TO-EXCEED) IN SOURCE SELECTION CRITERIA.

PURCHASE MAINTENANCE ITEMS NEEDED TO SUPPORT PLANNED MAINTENANCE CONCEPT.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PURCHASE DATA FOR A PARTS TRACEABILITY PROGRAM.

DO NOT ALLOW EITHER CONTRACTOR TO ENTER THE PRODUCTION PHASE UNTIL BOTH SOURCES ARE QUALIFIED (TECHEVAL AND OPEVAL).

IMPLEMENT PARALLEL PILOT PRODUCTION BEFORE PLACING COMPETITIVE PRODUCTION CONTRACTS.

IMPOSE STRICT CONFIGURATION CONTROL ON THE PRODUCT BASELINE DURING THE FSD AND PRODUCTION PHASES.

IMPOSE STRICT REQUIREMENTS ON USE OF NON-STANDARD TEST EQUIPMENT AND/OR PROCEDURES.

STAGE 4
APPLICATION GUIDELINES
D^3 DIRECTED LICENSING

INFORM ALL POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO IMPLEMENT COMPETITION.

PERFORM A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION TO THE SYSTEM LEVEL.

SEEK LEGAL COUNSEL BEFORE PLACING FSD CONTRACT TO FULLY UNDERSTAND LEGAL CLAIMS OF DEVELOPER.

DEVELOP CRITERIA FOR THE MANDATING OF DIRECTED LICENSING.

PROHIBIT THE USE OF PROPRIETARY AND/OR SOLE SOURCE PARTS TO THE MAXIMUM EXTENT PRACTICABLE.

RETAIN THE OPTION TO PURCHASE THE TECHNICAL DATA PACKAGE AND DATA RIGHTS (NOT-TO-EXCEED) AND INCLUDE THIS OPTION IN SOURCE SELECTION CRITERIA.

PURCHASE MAINTENANCE ITEMS NEEDED TO PERFORM PLANNED MAINTENANCE CONCEPT.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PROCURE DATA FOR A PARTS TRACEABILITY PROGRAM.

IMPOSE STRICT CONFIGURATION CONTROL ON THE PRODUCT BASELINE DURING THE PRODUCTION PHASE.

IMPOSE STRICT REQUIREMENTS ON USE OF NON-STANDARD TEST EQUIPMENT AND/OR PROCEDURES.

STAGE 4
APPLICATION GUIDELINES
D^3 LEADER-FOLLOWER

INFORM ALL POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO MOTIVATE LEADER AND DEVELOP FOLLOWER.

PREPARE A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION TO THE SYSTEM LEVEL.

DEVELOP CRITERIA FOR THE SELECTION OF THE FOLLOWER SOURCE AS PART OF FSD CONTRACT.

DEVELOP CONTRACT INCENTIVES TO ENCOURAGE THE LEADER TO ASSIST IN THE TRANSFER OF TECHNOLOGY AND PRODUCTION CAPABILITY TO THE FOLLOWER.

PROHIBIT THE USE OF PROPRIETARY AND/OR SOLE SOURCE PARTS.

RETAIN OPTION TO PURCHASE THE TECHNICAL DATA PACKAGE AND DATA RIGHTS (NOT-TO-EXCEED) AND INCLUDE IN SOURCE SELECTION CRITERIA.

PURCHASE MAINTENANCE ITEMS NEEDED TO SUPPORT PLANNED MAINTENANCE CONCEPT.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PURCHASE DATA FOR A PARTS TRACEABILITY PROGRAM.

IMPOSE STRICT CONFIGURATION CONTROL ON THE PRODUCE BASELINE DURING THE PRODUCTION PHASE.

IMPOSE STRICT REQUIREMENTS ON USE OF NON-STANDARD TEST EQUIPMENT AND/OR PROCEDURES.

STAGE 4
APPLICATION GUIDELINES
D^3 PERFORMANCE SPEC/MODEL/AVAILABLE DATA

INFORM ALL POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO IMPLEMENT PRODUCTION COMPETITION.

PREPARE A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION TO THE SYSTEM LEVEL.

DEVELOP SOURCE SELECTION CRITERIA TO ENSURE THE SELECTION OF A COMPETITIVE SOURCE THAT HAS SUFFICIENT CAPABILITY TO PERFORM REVERSE ENGINEERING AND EFFICIENT MANUFACTURING.

PROHIBIT THE USE OF PROPRIETARY AND/OR SOLE SOURCE PARTS.

PURCHASE THE TECHNICAL DATA PACKAGE AND DATA RIGHTS IN FSD CONTRACT.

PURCHASE MAINTENANCE ITEMS NEEDED TO SUPPORT PLANNED MAINTENANCE CONCEPT.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PURCHASE DATA FOR A PARTS TRACEABILITY PROGRAM.

IMPOSE STRICT CONFIGURATION CONTROL ON TECHNICAL DATA PACKAGE AND THE PRODUCT BASELINE DURING PRODUCTION PHASE.

PERFORM A DESK-TOP AUDIT OF THE TECHNICAL DATA PACKAGE BEFORE USING IT AS A BASIS FOR CONTRACTUAL REQUIREMENTS LEVIED ON COMPETITIVE SOURCE.

IMPOSE STRICT REQUIREMENTS ON USE OF NON-STANDARD TEST EQUIPMENT AND/OR PROCEDURES.

STAGE 4
APPLICATION GUIDELINES
D^3 INDEPENDENTLY VALIDATED DATA PACKAGE

INFORM ALL POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO IMPLEMENT PRODUCTION COMPETITION.

PREPARE A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION TO THE SYSTEM LEVEL.

PROHIBIT THE USE OF PROPRIETARY AND/OR SOLE SOURCE PARTS.

PURCHASE THE TECHNICAL DATA PACKAGE AND DATA RIGHTS AND INCLUDE IN SOURCE SELECTION CRITERIA.

PURCHASE ANY SPECIAL TOOLING AND TEST EQUIPMENT NEEDED TO VALIDATE THE DATA PACKAGE AND TO ESTABLISH THE PRODUCTION CAPABILITY AT THE COMPETITIVE SOURCE. INCLUDE IN SOURCE SELECTION CRITERIA.

PURCHASE MAINTENANCE ITEMS NEEDED TO SUPPORT PLANNED MAINTENANCE CONCEPT.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PURCHASE DATA FOR A PARTS TRACEABILITY PROGRAM.

CONTRACT WITH THE DEVELOPING SOURCE FOR TECHNICAL ASSISTANCE DURING DATA PACKAGE VALIDATION TO RESOLVE DISCREPANCIES IN THE DATA AND MANUFACTURING PROCESSSES.

IMPOST STRICT CONFIGURATION CONTROL ON TECHNICAL DATA PACKAGE.

VALIDATE THE TECHNICAL DATA PACKAGE BEFORE USING IT TO ESTABLISH A COMPETITIVE SOURCE.

IMPOSE STRICT REQUIREMENTS ON USE OF NON-STANDARD TEST EQUIPMENT AND/OR PROCEDURES.

STAGE 4
APPLICATION GUIDELINES
D^3 JOINT GOVERNMENT-INDUSTRY VALIDATED DATA PACKAGE

INFORM POTENTIAL CONTRACTORS OF PLANS FOR PRODUCTION COMPETITION.

BUDGET SUFFICIENT FUNDS TO IMPLEMENT PRODUCTION COMPETITION.

PREPARE A COMPLETE AND ACCURATE PERFORMANCE SPECIFICATION TO THE SYSTEM LEVEL.

PROHIBIT THE USE OF PROPRIETARY AND/OR SOLE SOURCE PARTS.

PURCHASE THE TECHNICAL DATA PACKAGE AND DATA RIGHTS AND INCLUDE IN SOURCE SELECTION CRITERIA.

PURCHASE ANY SPECIAL TOOLING AND TEST EQUIPMENT NEEDED TO VALIDATE THE DATA PACKAGE AND TO ESTABLISH THE PRODUCTION CAPABILITY AT THE COMPETITIVE SOURCE. INCLUDE IN SOURCE SELECTION CRITERIA.

PURCHASE MAINTENANCE ITEMS NEEDED TO SUPPORT PLANNED MAINTENANCE PHILOSOPHY.

RETAIN OPTION TO PURCHASE ALL OTHER MAINTENANCE ITEMS.

PURCHASE DATA FOR A PARTS TRACEABILITY PROGRAM.

CONTRACT WITH THE DEVELOPING SOURCE FOR TECHNICAL ASSISTANCE DURING DATA PACKAGE VALIDATION TO RESOLVE DISCREPANCIES IN THE DATA AND MANUFACTURING PROCESSES.

IMPOST STRICT CONFIGURATION CONTROL ON TECHNICAL DATA PACKAGE.

DEVELOP AN INTEGRATED PLAN FOR THE JOINT VALIDATION EFFORT THAT DESCRIBES THE TASKS TO BE PERFORMED AND THE SCHEDULE/ PHASING OF THE TASKS FOR THE GOVERNMENT, THE DEVELOPER AND THE COMPETITIVE SOURCE.

ESTABLISH SOURCE SELECTION CRITERIA TO ENSURE THE SELECTION OF A COMPETITIVE SOURCE THAT HAS SUFFICIENT ENGINEERING AND MANUFACTURING CAPABILITY TO VALIDATE THE DATA PACKAGE AS DEFINED IN THE PLAN.

VALIDATE THE DATA PACKAGE BEFORE ESTABLISHING PRODUCTION COMPETITION.

IMPOSE STRICT REQUIREMENTS ON USE OF NON-STANDARD TEST EQUIPMENT AND/OR PROCEDURES.

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The use of form, fit, and function in the acquisition of major weapon systems.